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BUILDING CONSTRUCTION

BUILDING CONSTRUCTION

FOR NATIONAL CERTIFICATE

VOLUME II

(Second Year Course)

BY

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PREFACE

THIS book is the second of a series of three which are intended to cover the first three years' syllabus of a National Certificate Course.

The object of this book is to encourage the study of building construction and to place in the hands of teachers and students a book which can be used as a class-book.

Also, it has been compiled to meet the requirements of students who are preparing for the Chartered Surveyors' Institution and other professional examinations in which the study of building construction forms part of the syllabus.

No attempt has been made to emphasise any of the phases of modern construction, because it is important that a student who is commencing the study of building construction should become acquainted with the fundamental principles of construction and traditional methods of building.

The author has endeavoured to assist the student to visualise the combination of constructional units by arranging the illustrations in the form of isometric sketches and with particular reference to a complete building.

The text is arranged in an abbreviated form of notes and includes a brief outline of the manufacture and uses of the various building materials illustrated throughout this volume.

The author wishes to express his thanks to the architects, Messrs. Johns & Slater, F. & A.R.I.B.A., for the use of the scale drawings of the Assembly Hall, etc., and to his son, Douglas, for his assistance in the preparation of these drawings.

E. G. W.

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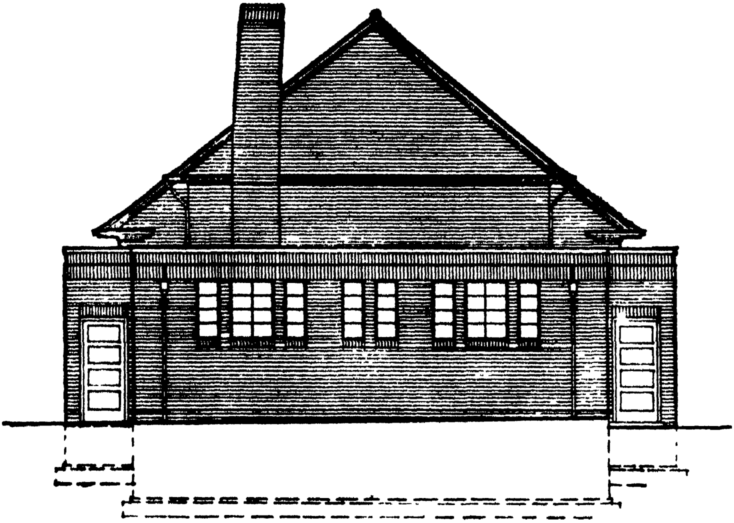

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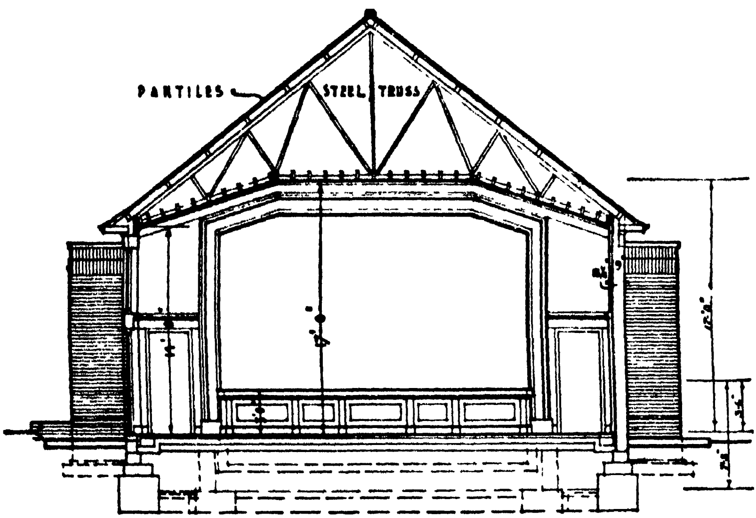

CROSS SECTION

'ohns and Slater, F. & A.R.I.B.A.
8 Lower Brook Street,
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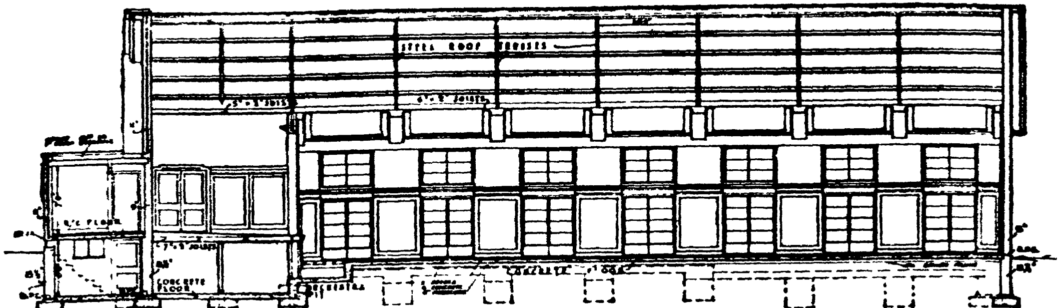
FRIENDS SCHOOL SAFFRON WALDEN NEW ASSEMBLY HALL



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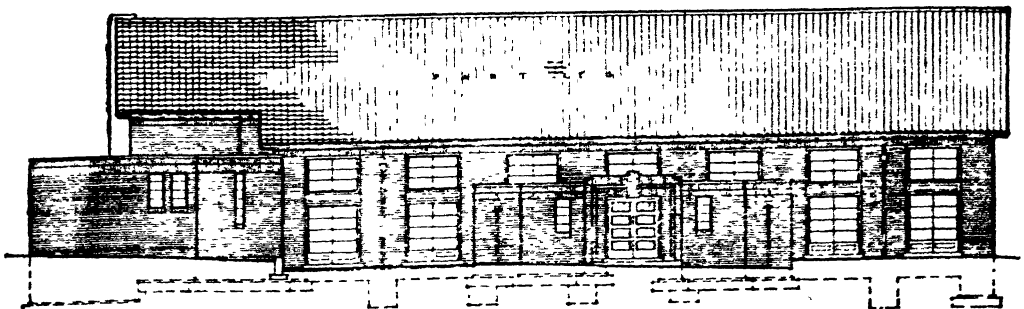

EAST ELEVATION

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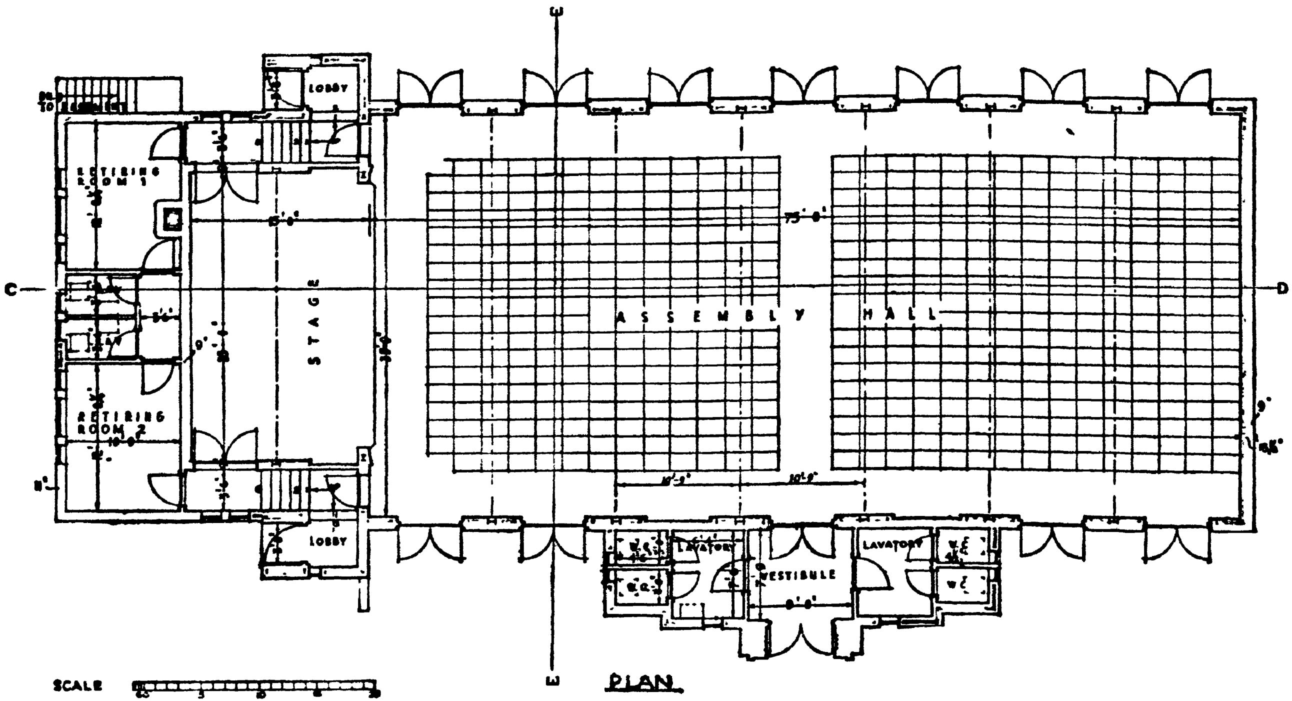


PLAN

LIST OF ILLUSTRATIONS

CHAPTER I

EXCAVATIONS AND TIMBERING TRENCHES

WHEN excavations for foundations and drains are to be dug in soil that is liable to fall away from the sides of the trench, they should be timbered in a manner that will prevent this occurring.

Shallow Trenches in Loose Soil

In loose soil the sides of shallow trenches may be sloped instead of being vertical, but if they are more than 4′ deep, vertical strutting and planking would be preferable, and such precautions are absolutely necessary to prevent accidents arising through the collapse of the sides.

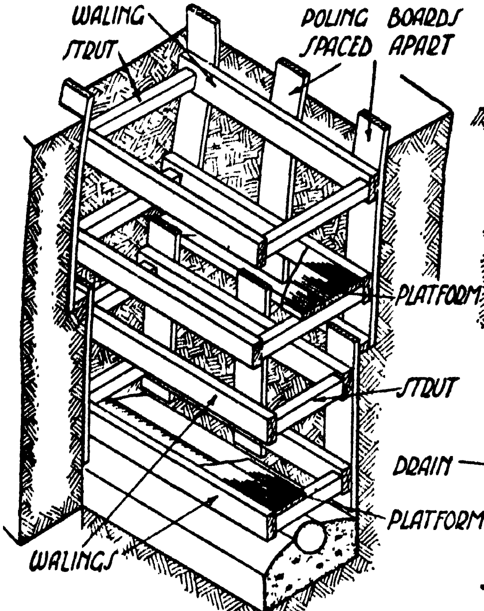
Figs. 1 and 2 illustrate how a trench in loose soil may be timbered.

The sheeting boards are placed horizontal and close together against the sides of the trench, which is excavated in stages equal to the width of one or two boards.

The boards are strutted with temporary struts as the work proceeds, and when a sufficient depth has been reached (this is usually to the depth of four boards) vertical walings are placed in position across the boards and strutted so that the temporary struts can be removed. This process is repeated until the required depth is reached.

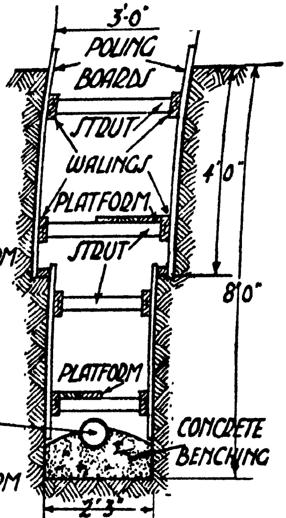
Stepped Trenches

The width of the trench has very little influence on the method of timbering, but the depth of a trench will regulate the timbering and also the shape of the trench. For deep excavations in firm and loose soils, stepped trenching is advisable. In firm soils the excavation is taken down in about 4′



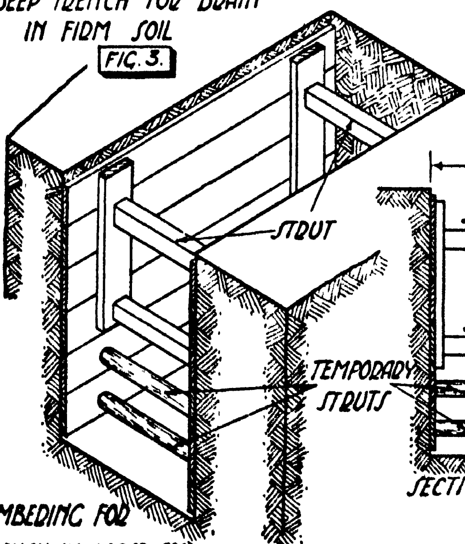
TIMBERING FOR DEEP TRENCH FOR DRAIN IN FIRM SOIL

FIG. 3.

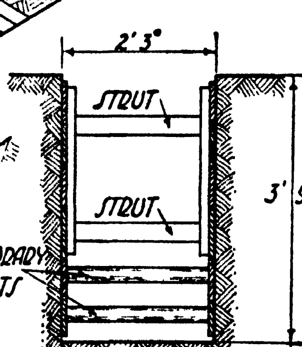


SECTION THRO' TRENCH

FIG 4



TIMBERING FOR TRENCH IN LOOSE SOIL



SECTION THRO' TRENCH

FIG. 2.

lifts and the sides of the trench are supported by poling boards spaced apart and strutted, as shown in Figs 3 and 4.

Steps are formed by narrowing the trench at each lift and then repeating the excavation and timbering until the required depth is reached.

Working platforms should be formed at various convenient levels in the trench, so that the earth can be thrown from one level to another in successive lifts of about 4′.

Stepped trenches in loose soils should be timbered as shown in Figs. 5 and 6.

In this example, short poling boards are used so as to reduce the amount of excavation required for each successive lift. The poling boards should be close-jointed and strutted as shown in the sketch.

Timbering for Basement Excavations

The timbering for basement excavations is best carried out in the form of trenchings of sufficient width for the wall foundation and the earth in the centre of the site allowed to remain intact until the basement walls are built. This centre mound of earth is termed the ' Dumpling ' and may be used as an abutment for the struts, as shown in Fig. 7.

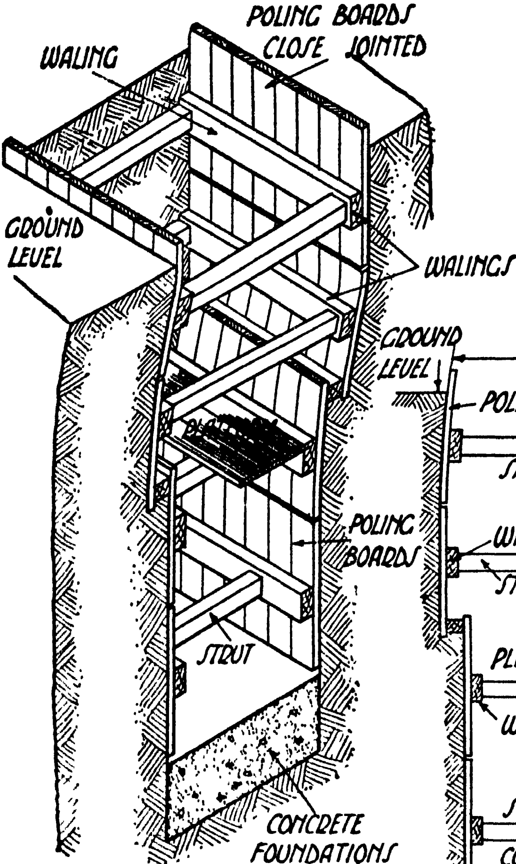
The stage at which the struts can be removed depends very much upon circumstances, but usually they can be withdrawn as the building of the walls proceeds, that is, when they get in the way of the brickwork.

The struts should be replaced by short props wedged between the face of the brickwork and the poling boards. These props should be placed on both sides of the wall and allowed to remain in position until the wall is built up beyond the ground level.

The vertical damp-proof course should be placed in position against the outside surface of the wall and the props removed as the trench is being refilled with well-rammed earth.

The next procedure is to excavate the central mound of earth to the depth required, which is usually regulated by the position of the surface layer of concrete.

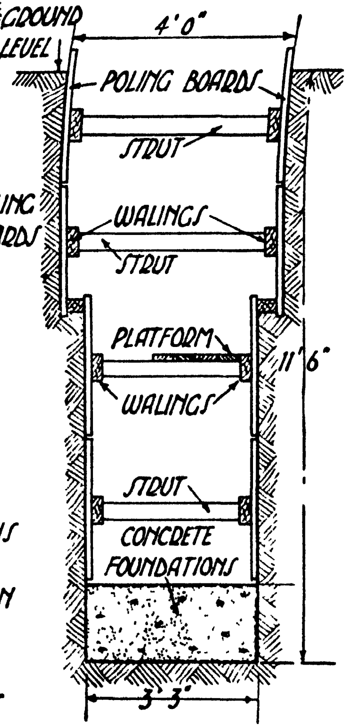
The process of allowing the ' dumpling ' to remain until the



SKETCH SHOWING POSITION OF TIMBERING

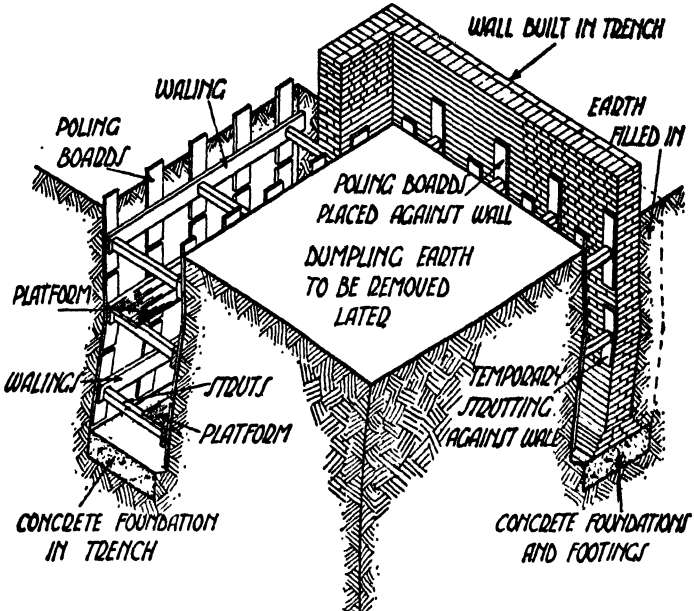
TIMBERING FOR TRENCHES IN LOOSE EARTH

FIG 5.



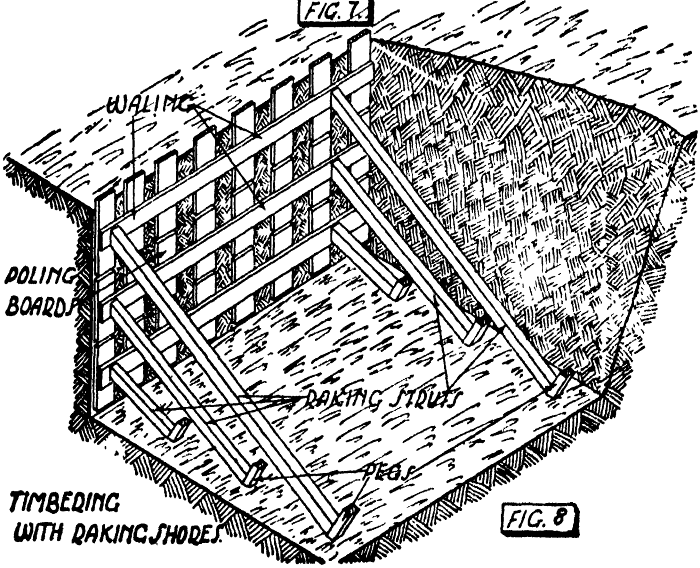
SECTION THRO' TRENCH

FIG. 6



EXCAVATION AND TIMBERING FOR BASEMENT WALL

FIG. 7.



TIMBERING WITH RAKING SHORES.

FIG. 8

walls are built will eliminate the use of raking struts or shores, and by so doing, will expedite the completion of the work. A sketch showing the raking shores in position is given in Fig. 8.

Trenches dug in wet ground must be kept free from water by pumping and baling as required.

CHAPTER II

BASEMENT WALLS AND FLOORS

THE construction of basement walls require treatment similar to the bases of the walls dealt with in Vol. I.

Damp-proofing

The prevention of damp penetration through basement floors and walls necessitates special provision in their construction to guard against damage due to water pressure.

A head of water is frequently encountered in deep excavations, and there is a likelihood of moisture penetrating the walls that are in immediate contact with the surrounding soil.

Water pressure under basement floors may be relieved by placing a system of surface drainage pipes over the site and under the concrete floor.

If this is done the moisture may be conveyed through the pipes and discharged into a soak-away or into the drainage system.

These surface drainage pipes will only relieve the water pressure and not prevent the moisture penetrating the walls and floor, and therefore some form of damp-proofing must be incorporated in their construction.

As explained in Vol. I, there are three methods of damp-proofing viz:

(1) Membrane damp-proofing.

(2) Integral damp-proofing.

(3) Surface treatment.

For the construction of single basement floors and walls it is preferable to combine membrane damp-proofing methods with surface treatment, by placing an impervious layer within the thickness of the floor concrete and over the whole of the floor area and up the outside surface of the walls.

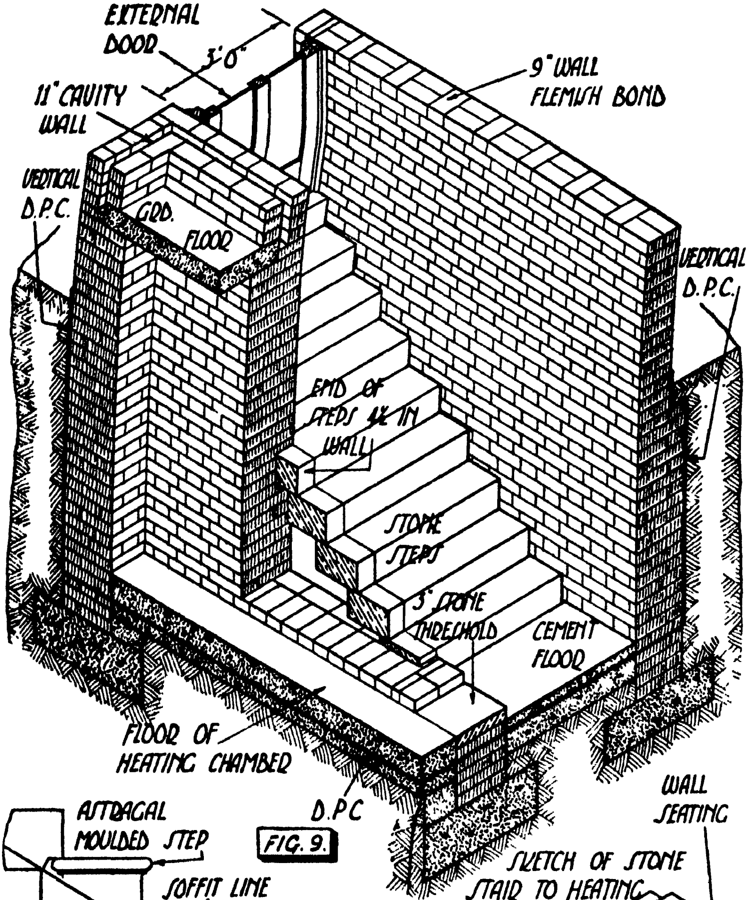
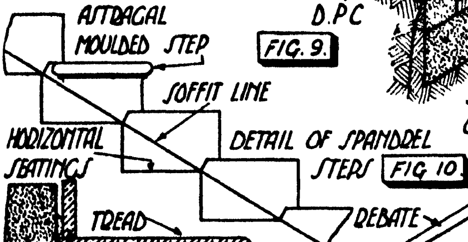


FIG. 9.

SKETCH OF STONE STAIR TO HEATING CHAMBER



DETAIL OF SPANDREL STEPS FIG 10.

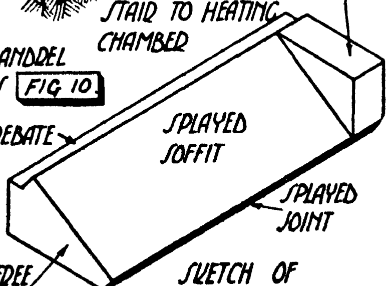
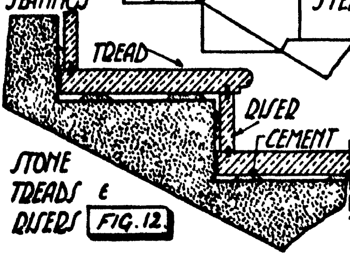
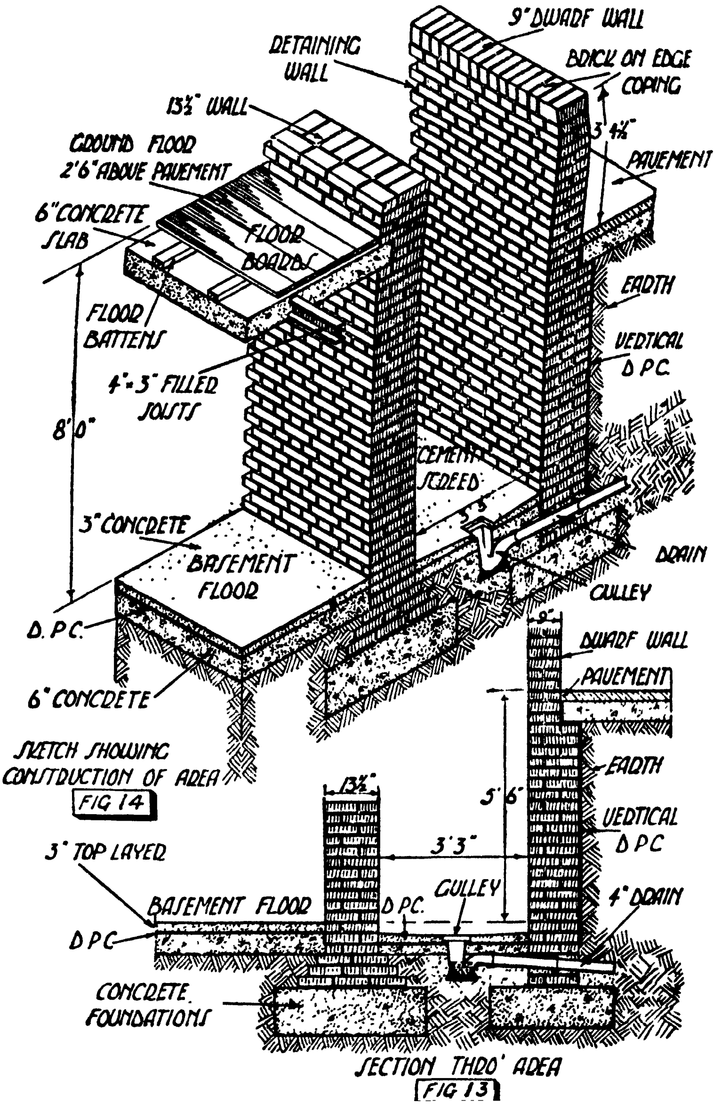


FIG. 11. SKETCH OF SPANDREL STEP



STONE TREADS & RISERS FIG. 12.



SKETCH SHOWING CONSTRUCTION OF AREA
FIG 14

SECTION THRO' AREA
FIG 13

into a soak-away, providing circumstances and site conditions permit.

The position of the soak-away is shown on the drainage plan Fig. 176.

A sketch showing the construction of a basement floor and wall and the arrangement of the D.P.C. is given in Fig. 15.

CHAPTER III

BRICKWORK BOND

ALTHOUGH an endeavour has been made to illustrate correct bonding for various examples of brickwork, it is not advisable for students to spend too much time trying to unravel the mysteries of correct bonding connected with complicated pieces of work. The function played by Portland cement and hydrated lime mortars has largely superseded the function of correct bonding, except in regard to appearance. Success will be achieved if the essential requirements are understood.

Bond in brickwork has been described in Vol. I of this series and examples of brick bonding are illustrated therein for walls up to two bricks thick.

Brick Quoins

Sketches showing the alternate courses of a square quoin at the junction of a two and a half brick wall built in English bond are given in Fig. 16.

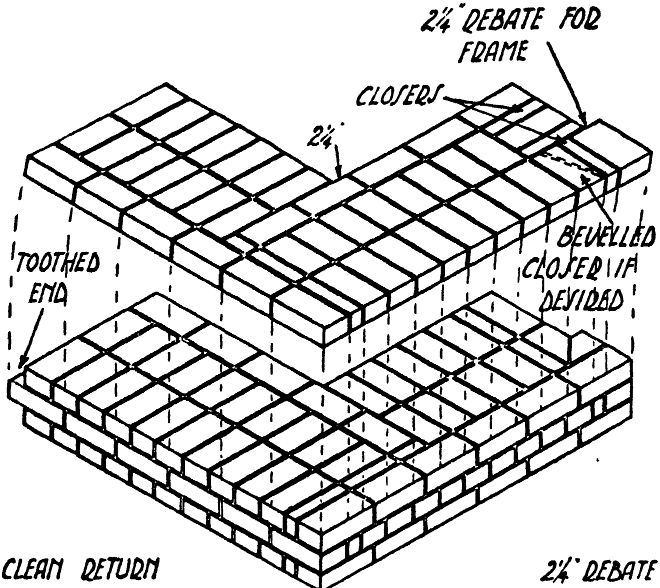
The left-hand end is left toothed, but at the right-hand end the bonding is arranged for the side jamb of a door or window opening with a 9" reveal and 2¼" rebate for frame.

Figs. 17 shows the bonding for the alternate courses of a two and a half brick wall built in Flemish bond. In this example a clean return end is shown on the left-hand side, and the bonding for the jamb of a door or window opening is shown on the right-hand side.

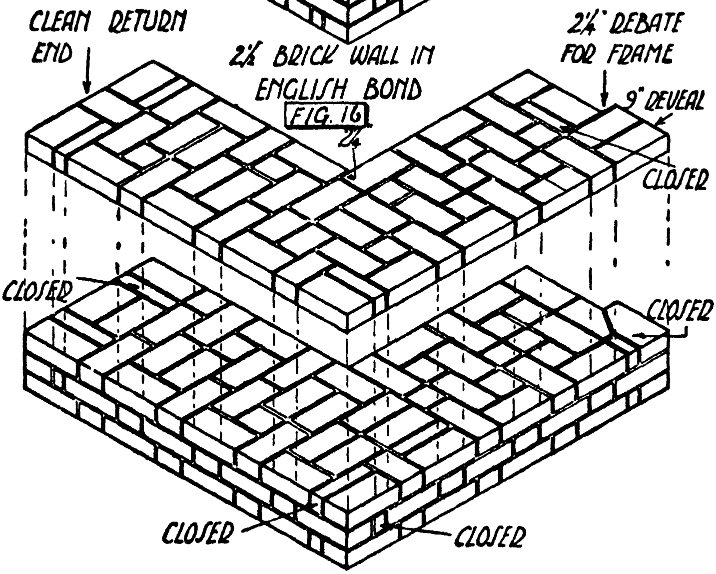
Squint Quoins Figs. 18–26

When walls meet an angle other than a right angle, the quoin is termed a squint quoin and the angle made by the intersection of the two walls may be acute or obtuse.

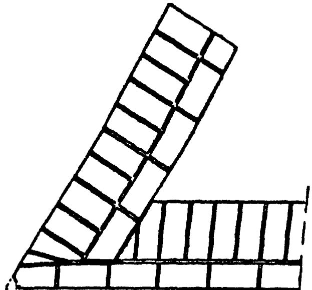
The principle of bonding acute and obtuse angles in brick-



2½ BRICK WALL IN ENGLISH BOND
FIG. 16



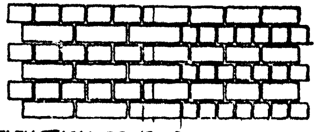
2½ BRICK WALL IN FLEMISH BOND
FIG. 17.



ACUTE SQUINT QUOIN IN ENGLISH BOND

FIG 18

SHARP ANGLE SPLAYED OFF



ELEVATION OF ANGLE BRICKWORK

FIG 26

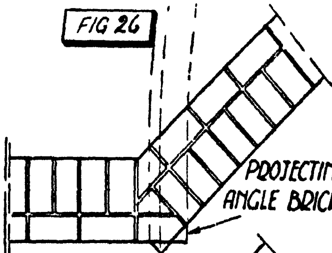
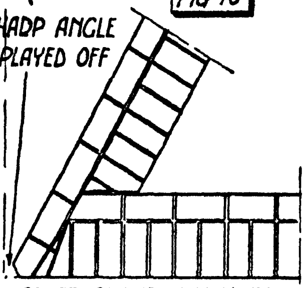
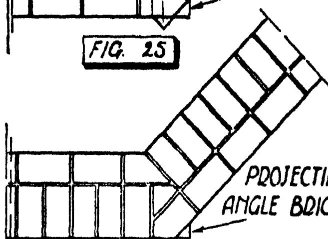


FIG. 25



ACUTE SQUINT QUOIN IN ENGLISH BOND

FIG 19



ALTERNATIVE TREATMENT AT ANGLE

FIG 24

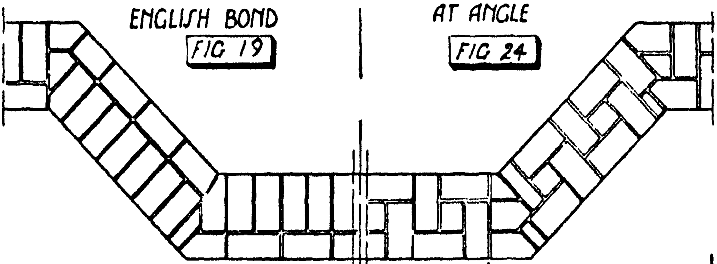


FIG 20

FIG 22

OBTUSE SQUINT QUOINS.

ENGLISH BOND FLEMISH BOND

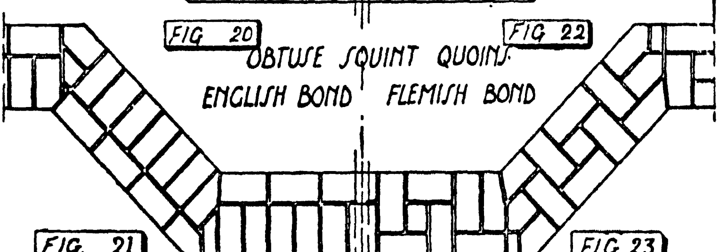


FIG. 21

FIG 23

work is similar to that adopted for right-angle quoins, but usually a greater number of cut bricks are necessary in forming the bond.

The bonding for the alternate courses for an acute angle in a 13½" wall, built in English bond, is shown in Figs. 18 and 19. Figs. 20 and 21 illustrate the bonding for the alternate *courses for obtuse quoins in a 13½" wall built in English bond. In these examples both external and internal angles are shown. The arrangement for the bricks when similar quoins are built in Flemish bond are illustrated in Figs. 22 and 23.*

It will be seen that these plans form an outline suitable for the walls of a bay window.

Special treatment at the quoin angles is often adopted and purpose-made bricks are often used, but in the example given in Figs. 24–26 a special feature is made by using ordinary facing blocks as the quoin bricks and allowing them to project on each side of the angle of intersection alternately with each course.

Attached Piers are the projections built out from the wall to give extra strength to the wall and assist in resisting lateral thrusts. They also provide a larger bearing area for spreading the weight occasioned by vertical loads from floors and roof.

Figs. 73 shows the arrangement of the bonding for an 18" × 4½" pier, attached to a 13½" wall built in English bond.

Fig. 72 shows the end of a R.S.B. resting on a stone template which is intended to distribute the load from the R.S.B. over the whole area of the pier.

Fig 74 illustrates the bonding for two types of attached piers built in Flemish bond and forming part of the same wall.

CHAPTER IV

CAVITY WALLS

In positions exposed to driving rains it is often found that moisture will penetrate external brick walls of ordinary thicknesses.

To prevent this, special vitrified bricks, bedded in cement mortar may be used, but it is often found that a cavity, or air space, formed in the thickness of the walls will be an effective means of preventing damp transmission.

The success of the function for which cavity walls are constructed will depend upon correct design and construction.

When forming a cavity it is usual to build a 4½" external wall and a 4½" or 9" internal wall, or vice versa, and the width of the cavity is either 2" or 2¼".

The external walls of the Assembly Hall, which is illustrated in the front of this book, will be seen to comprise a 9" thick external wall and a 3" thick inner wall, built with partition blocks.

A sketch showing the construction through one of the window openings is given in Fig. 161.

If the loads from the floors and roof are to be carried by the internal wall, the wall must be increased in thickness so that it will safely carry the loads.

In the example mentioned above, the roof loads are not borne by the walls because they are transmitted as point loads to the foundations through the medium of rolled steel stanchions, situated at the feet of the steel roof trusses.

The provision of a continuous cavity in a wall is the most efficient means for preventing damp transmission to the inner wall, but great care is required in the design and construction of the wall if this continuity is to be maintained.

Construction at Base of Wall

The cavity should commence at about ground level and terminate at about eaves level, or above roof level in the case of a flat roof surrounded by parapet walls. Air bricks should be built in the external wall as near as possible to the bottom and top of the cavity.

Figs 27 and 28 illustrate the construction of the foundation and base of an 11½″ cavity brick wall in conjunction with a concrete ground floor. The details show the position for the D.P.C. and the air bricks. If the ground floor is constructed with timber joists, air bricks should be built in the inner wall just below the floor surfaces.

Bonds in Cavity Walls

Although stretching bond is often used in the construction of cavity walls that have an external 4½″ wall, a more pleasing appearance can be obtained and with very little extra expense by adopting Flemish bond.

When Flemish bond is used for such walls the headers are snapped as shown in Fig. 31.

Although stretching bond is more economical in a 4½″ wall the appearance of the finished work lacks character, as may be seen in Figs. 27 and 35.

Cavity Wall Ties

It is essential that the two walls are tied together to prevent buckling due to wind pressure, or by the application of superimposed loads from the floors and roof.

There are various forms of ties, but the most effective appears to be those made of metal (galvanised iron is quite suitable for this purpose).

The ties should be twisted in crossing the cavity so that any water that may collect on them will drop clear of the inner wall.

The ties should be built in the walls and across the cavity at about 3′ intervals horizontally and 12″ to 18″ vertically.

It is preferable that they should be fixed in a staggered position throughout the height of the wall so that water,

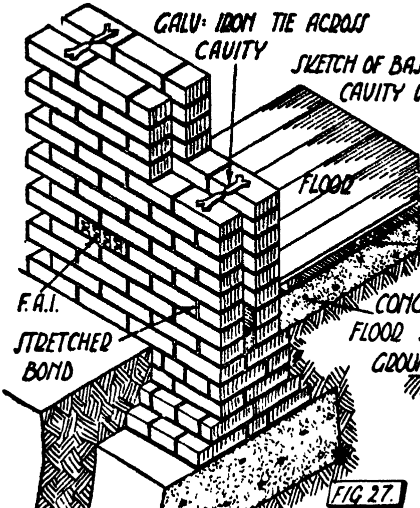
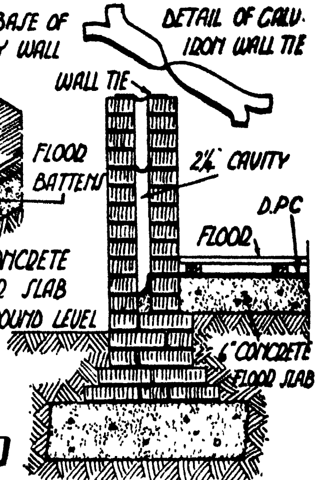
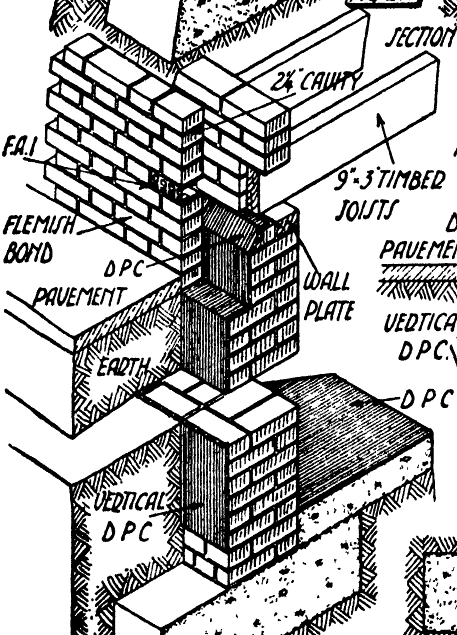


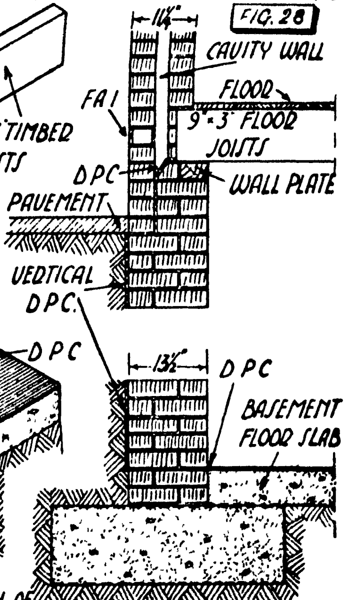
FIG 27.



SECTION THRO' BASE OF CAVITY WALL
FIG. 28



SKETCH OF BASEMENT WALL AND BASE OF CAVITY WALL
FIG. 29



SECTION FIG 30

dropping from the ties above, will not drop on those immediately below.

When building cavity walls care must be exercised in keeping the cavity clear of mortar droppings because the existence of such material in the cavity will form a bridge for the transference of moisture to the inner wall.

Cavity walls are claimed to assist the insulation of a building from the vagaries of climatic conditions by conserving the heat within a building, because the air in the cavity tends to prevent the too rapid conduction of the internal heat to the outside in winter time, and retards the inward transmission of heat in the summer time.

Cavity Walls over Basement Walls

Figs. 29 and 30 illustrate the construction of a cavity wall, the base of which is a solid brick basement wall.

The cavity commences just above pavement level and the D.P.C. is situated so as to exclude dampness from the basement.

A timber wall plate is shown in the drawings, but a brick course and metal flat may be used if preferred.

The construction of the cavity wall commencing from the solid wall of the heating chamber of the Assembly Hall, is shown in Fig. 75.

The vertical D.P.C. in front of the solid wall finishes just above pavement level and another D.P.C. is placed across the lower part of the cavity.

CHAPTER V

CAVITY WALLS *(Continued)*

Construction at Side of Openings

SPECIAL consideration is necessary in the construction of cavity walls where they occur at the sides of door and window openings.

These are vital points in cavity wall construction, as dampness, due to driving rains, is very liable to pass through to the inner wall at these points. The cavity at the sides of an opening may be filled with bricks or bonded as for a solid wall, as shown in Fig. 161.

An improvement on this method is to fill the cavity with vertical courses of slates or tiles bedded in Portland cement mortar, as shown in Figs. 31 and 32.

But these methods do not appear to exclude dampness under certain conditions, although they may be considered the most reliable methods when wood frames are used.

Another method is shown in Fig. 33.

A strip of sheet lead is nailed to the wood frame and dressed into the cavity at the sides of the opening. The edges of the lead strip are turned and dressed over in the form of a welt. Although this construction appears to be effective, in practice very little benefit is derived by its inclusion, because moisture will tend to creep through the joint between the wood frame and the lead.

Figs. 35, 36 and 37 are details illustrating the construction at the side of an opening in a cavity wall fitted with a metal window-frame that has been designed especially for fixing in openings in cavity walls.

Construction at Sill Level

When a stone sill is incorporated in the construction of a window opening, it is advisable to keep the back of the sill

flush with the back surface of the external wall, that is, the stone should rest 4½″ on the wall and 9″ in the case of a 9″ external wall.

By this arrangement the cavity is permitted to continue to the top of the sill as shown in Fig. 37.

When 4½″ reveals are desired at the sides of openings in a cavity wall it is sometimes necessary to increase the width of the stone sill so that it bridges the cavity, as shown in Fig. 31.

In such cases it is advisable to bed the stone sill on a strip of sheet lead, the back edge of the lead being turned up against the back surface of the sill. A metal sill surmounting a stone sill is illustrated in Figs. 35–37, and a section through a tile sill is given in Fig. 34.

Construction at Top of Openings

Openings in cavity walls may be bridged by means of brick or stone arches, or stone or concrete lintols, but their construction must be such that the function of the cavity is not impaired.

Figs. 38 and 39 show the construction of a brick soldier arch over an opening in a cavity wall.

A strip of sheet lead bridges the cavity and is dressed in the form of a gutter over the opening, so that any moisture which may accumulate over the opening is discharged into the cavity at the sides of the opening.

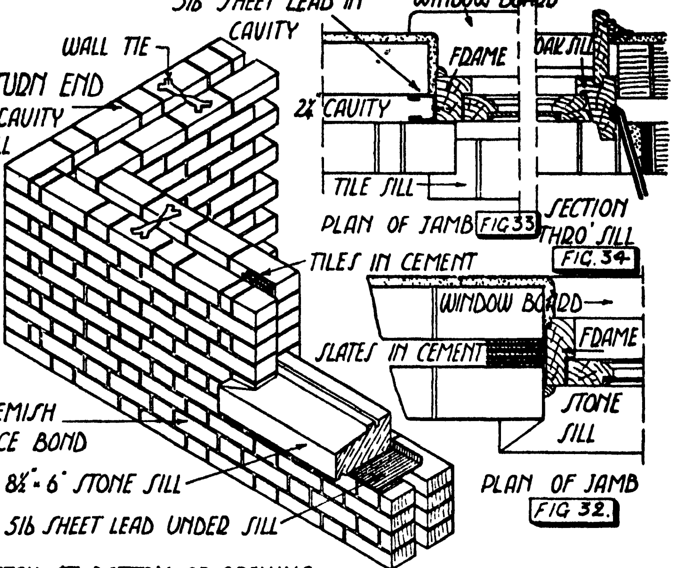
The lead is shown continued beyond the face of the external wall and dressed so as to form a drip over the face of the brick arch.

Figs. 40 and 41 illustrate the construction of a stone head surmounted by a stone moulding or label course.

In this example the external wall is shown 4½″ thick and the inner wall 9″ thick.

A strip of 5lb. sheet lead is dressed over the opening so that any moisture that may accumulate on the lead is conducted to the external wall.

The lead is continued through the external wall and dressed over the nosing of the projecting stonework, so as to form a drip.

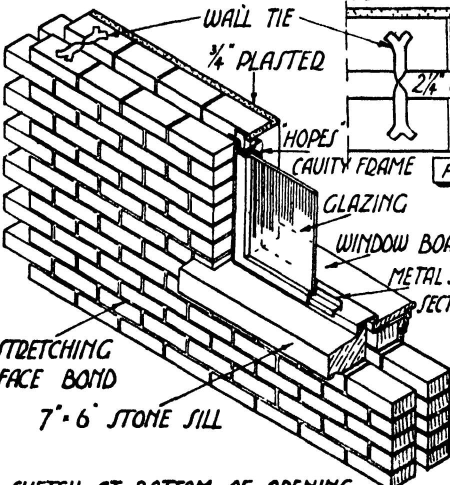


SKETCH AT BOTTOM OF OPENING IN A CAVITY WALL FIG 31

PLAN OF JAMB FIG 33

SECTION THRO' SILL FIG. 34

PLAN OF JAMB FIG 32.



SKETCH AT BOTTOM OF OPENING IN A CAVITY WALL FITTED WITH METAL WINDOW FRAME FIG 35

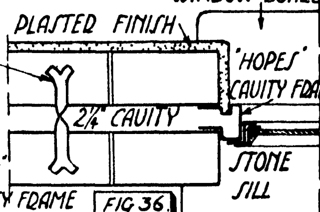


FIG 36. PLAN OF JAMB

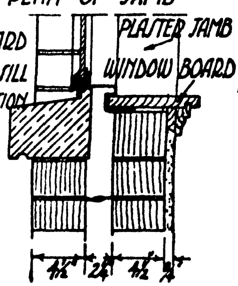
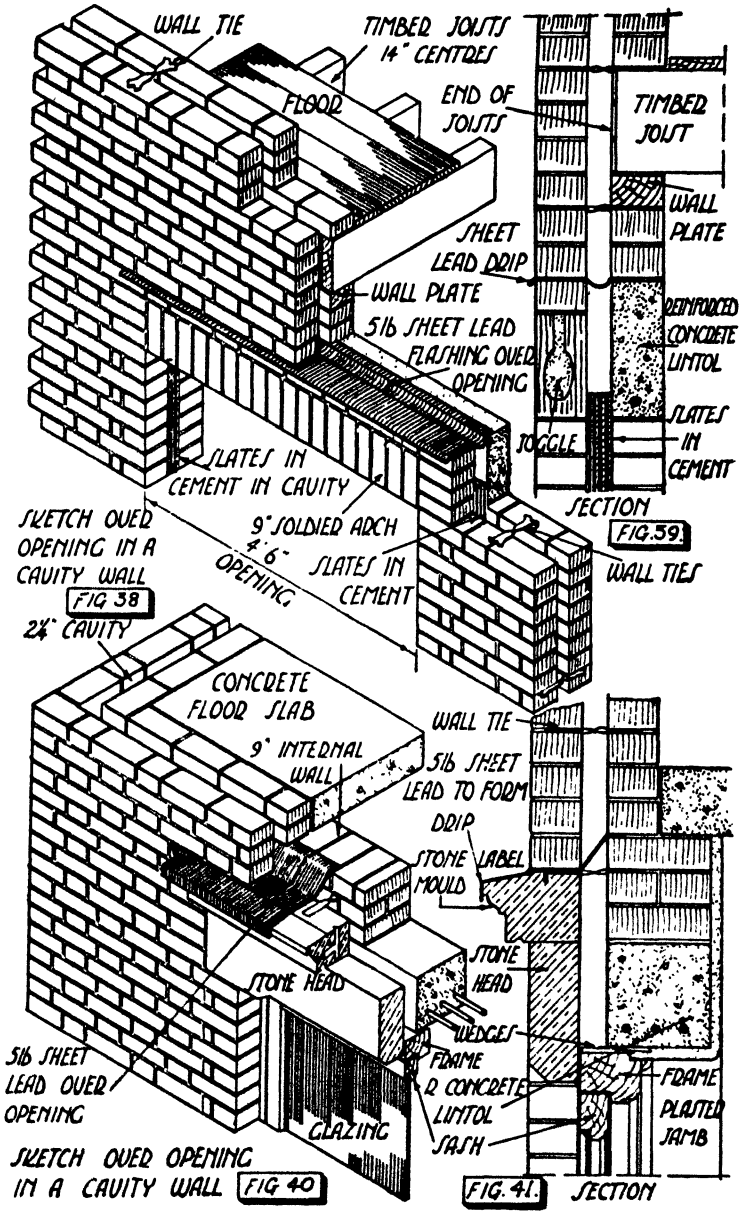


FIG.37



SKETCH OVER OPENING IN A CAVITY WALL FIG 38

FIG. 39

SKETCH OVER OPENING IN A CAVITY WALL FIG 40

FIG. 41.

Construction at Roof Levels

When constructing cavity walls it must be remembered that dampness will travel down the wall from the top surface and penetrate to the interior wall unless precautions are taken to interrupt its path. It is essential also that the top of the cavity should be provided with means for the free circulation of the air in the cavity.

This is accomplished by a free use of air bricks placed in the external wall as shown in Fig. 100 or they may be inserted at the inside of the parapet wall, as shown in Fig. 99.

When the wall is terminated by a parapet the cavity may be continued through the parapet wall and terminate under the coping stones as shown in Fig. 77, or the cavity may be closed just above roof level and the top portion of the parapet finished as a solid wall, as shown in Figs. 99 and 100.

In each case it is necessary to provide an efficient D.P.C. placed across the wall, as shown in the sketches, or a course of slates may be bedded under the coping stones, as shown in Fig. 77.

The construction at the top of the cavity walls of the Assembly Hall including the detail of the eaves construction may be seen in Fig. 110.

CHAPTER VI

CONSTRUCTION OF FIREPLACES, FLUES, STACKS AND BRICKWORK DETAILS

ALTHOUGH the construction of fireplace openings, flues and chimney-stacks were dealt with in Vol. I, it is necessary in this course to extend the information to the more complicated types.

Fireplaces

Fireplaces are formed by building out attached piers from party or external walls and usually they are built-up from the foundation concrete, but in some instances they are corbelled out at an upper floor level.

These attached piers form the jambs at the sides of the fireplace openings, their projection from the wall being sufficient to accommodate the flues and the requisite thickness of brickwork around the flues. The back of fireplace openings in party walls must be 9″ thick, up to a height of 12″ above the lintol over the opening.

Although the minimum thickness for the back of fireplace openings on external walls is 4½″, it is advisable to adopt a minimum thickness of 9″, and wherever possible, fireplaces should be arranged on internal walls, so that the interior of the building may benefit from the heat radiating from the flues.

Arrangement of Fireplaces.—Fireplaces may be arranged in several different ways:

(1) By projections into a room, as shown in Fig. 42.

(2) By projections on the external face of a wall, as in Fig. 43.

(3) By placing the fireplace opening back-to-back, as shown in Fig. 44.

This arrangement is generally adopted when fireplaces are

built on a party wall and in such cases, one fireplace back serves the two fireplaces.

(4) By arranging the fireplaces in a staggered position so that the projection of the chimney-breasts are placed side by side on either side of the wall, thereby economising in space by reducing the projection, as shown in Fig. 45.

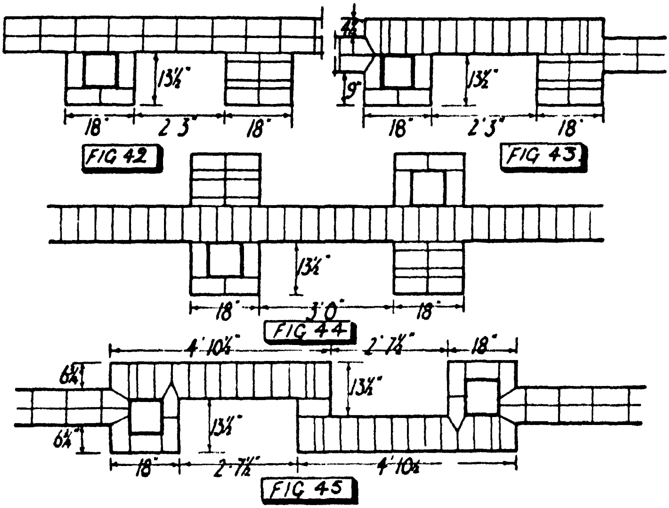


FIG 42 FIG 43 FIG 44 FIG 45

Angle Fireplaces

Fig. 46 shows the plans of a pair of fireplace openings built across the angles of two rooms, and when placed in this manner the fireplaces occupy comparatively little space, but the bonding of the brickwork necessitates a fair amount of brick cutting.

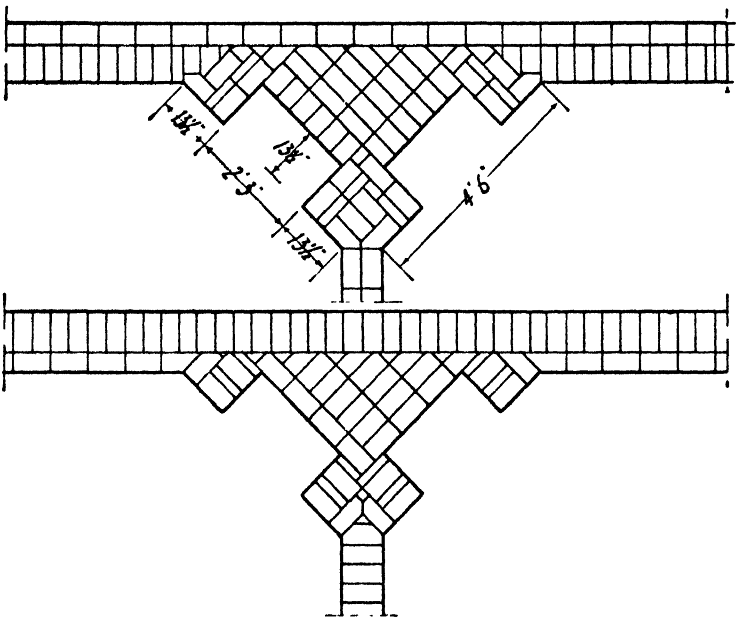
The flues leading from these fireplaces are often gathered over to the flues leading from the fireplace openings on the floor above, and terminating in separate chimney-stacks, or they may continue up direct and grouped into one stack.

Precast Concrete Hearth Slabs

Fig. 47 illustrates the construction of the floors, hearth and trimming for the fireplaces situated at ground and upper floor levels, the position of the flues being indicated in dotted lines.

The hearth slabs shown in Fig. 47 are of precast reinforced concrete instead of being cast *in situ*. This method of forming the hearth is preferable, especially when the fireplace is situated at ground-floor level.

The front portion of the hearth slab is supported on a straight-through fender wall without return ends and built up from

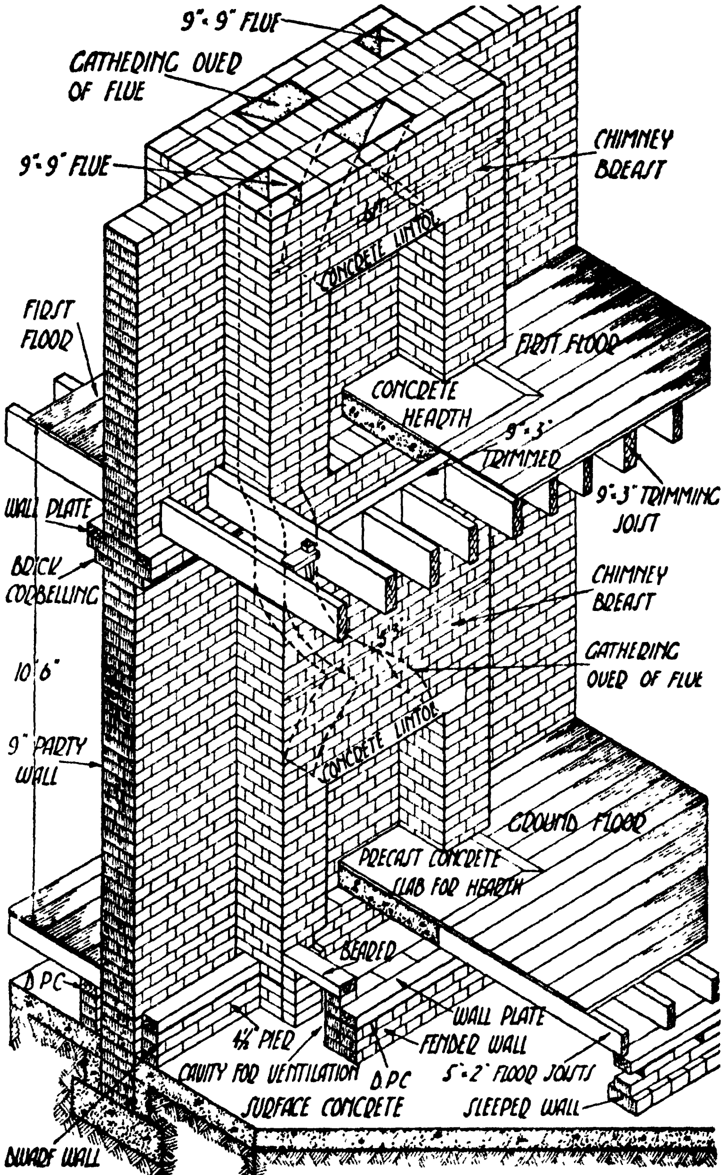


PLANS OF ALTERNATE COURSES FOR
AN ANGLE PLACE FIG. 46.

the surface concrete at the required distance from the face of the jambs.

The back corners of the slab are pinned into the brickwork of the jambs, and the space under the hearth slab is left free from hard-core filling, thereby assisting the cross ventilation of the space under the floor.

Precast concrete lintols are shown over the fireplace openings, but these may be omitted and substituted by rough brick arches if the latter are preferred.



CONSTRUCTION OF FIREPLACES AND FLUES IN PARTY WALL FIG. 47

Flues

Particular attention should be given to the direction of the flues as indicated in dotted lines in the drawings.

Flues should be neither larger nor smaller than is necessary for the conveyance of the smoke and heated air. A 9″ × 9″ flue is considered sufficient in size for ordinary grates, while for kitchen stoves and boilers 14″ × 9″ flues are often suggested to be more suitable.

The bonding of the chimney-breasts must allow for the accommodation of the flues, and where corbelling-out is necessary it should be carried out within the thickness of the upper floors.

To accommodate the flue which leads from the ground floor fireplace shown in Fig. 47 it is necessary to corbel out the side of the chimney-breast 4½″, because the width of the jamb to the upper floor fireplace has been increased from 13½″ to 18″.

The right-hand jamb is also increased to 18″ to maintain a balance.

Chimney-stacks

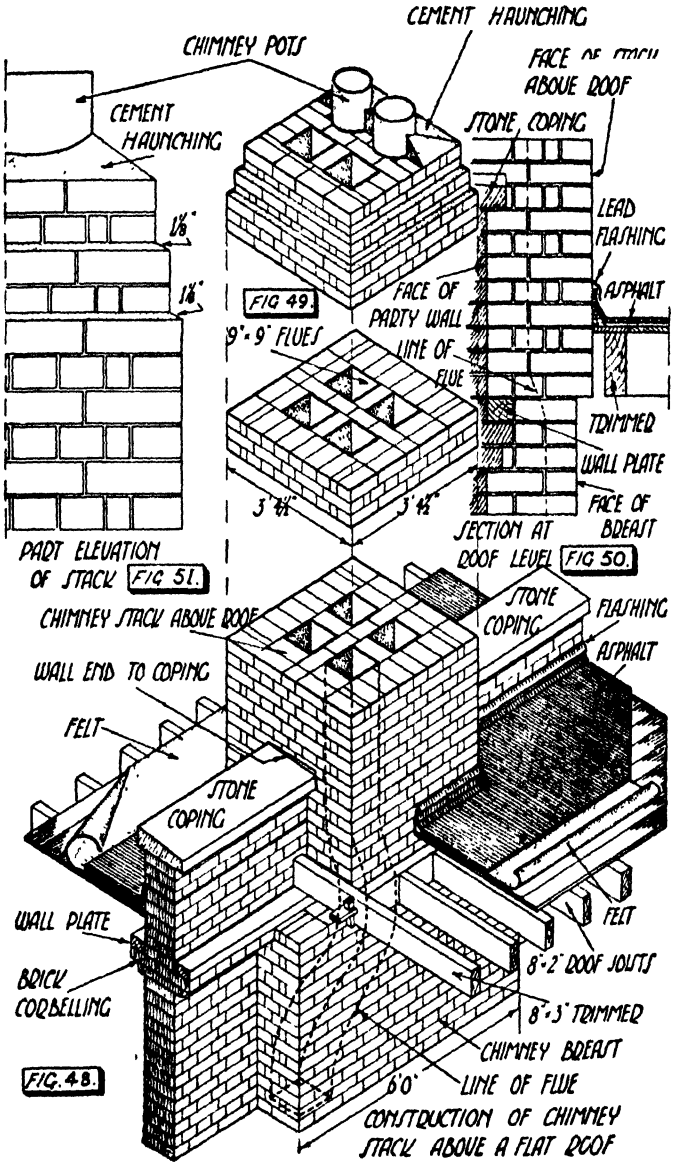
Until fireplaces are dispensed with for other forms of heating, chimney-stacks are essential for the termination of flues from fireplaces.

The bonding of the brickwork for chimney-stacks will depend upon the thickness of the walls, but Flemish bond is the most suitable if the external walls of the stack are only 4½″ thick.

The bonding must be arranged to accommodate the flues which are grouped together in the stack and to ensure that the cross walls, or ' withs,' are bonded, or tied into the external walls.

Height of Chimney-stacks.—Chimney-stacks should be built to a minimum height of 3′ above the highest point of intersection with any part of a roof, and to avoid any tendency to down-draught, they should be terminated 2′ above any adjoining ridge, and where a chimney-stack emerges above a flat roof its height should not exceed six times its shortest side.

The construction of a chimney-stack usually necessitates



PART ELEVATION OF STACK FIG 51.

FIG 49.

SECTION AT ROOF LEVEL FIG 50.

FIG. 48. CONSTRUCTION OF CHIMNEY STACK ABOVE A FLAT ROOF

the gathering over of the flues from their position within the chimney-breasts and below the roof surface, as indicated by dotted lines in the sketch.

Construction of Stack at Roof Level.—To enable 9" external walls to be adopted for the chimney-stack, Fig. 48, it has been necessary to increase its width by corbelling out the face of the chimney-breast at roof level as shown in section Fig. 50.

The trimming for the roof timbers round the chimney-stack and the construction and finish for the built-up roof, together with the method usually adopted for the termination of the party wall are shown in Fig. 48.

A feather-edge stone coping is shown surmounting the party wall, and the stone against the stack is bonded into the stack and finished with an ashlar-stop, worked out of the solid and flush with the face of the stack.

Part elevation of the top portion of the chimney-stack is given in Fig. 51.

Chimney-pots

Chimney-stacks are usually terminated with one of the many forms of fire-clay or terra-cotta pots.

There are many patented designs for these and the chief virtue claimed is that they increase the velocity of the rising air.

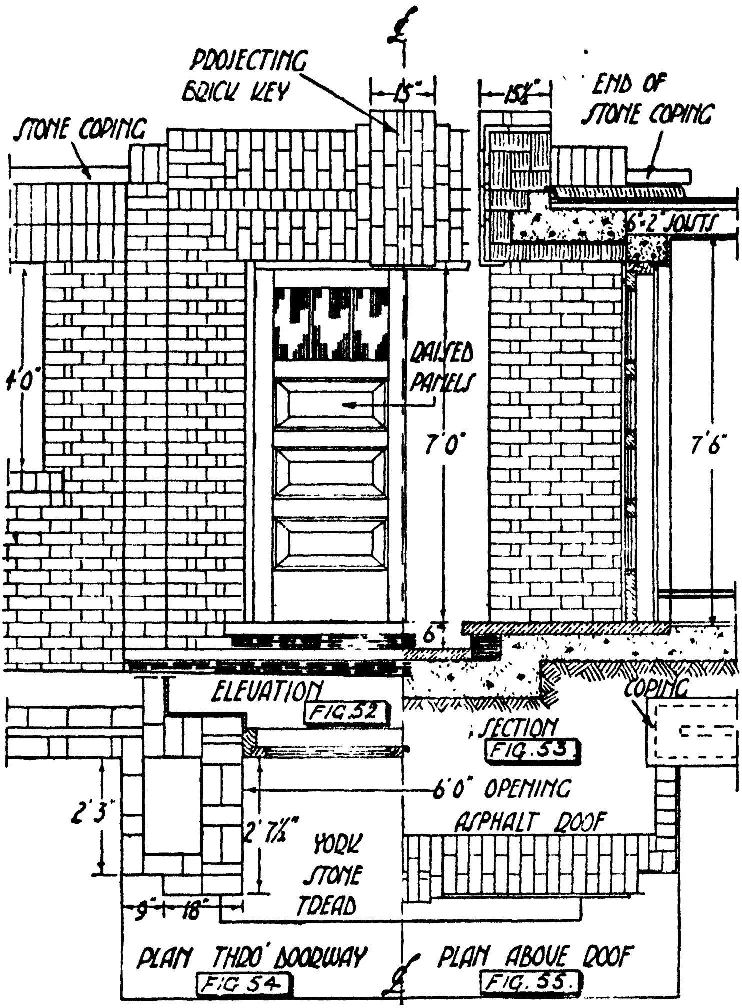
Simple cylindrical pots are shown in the drawings as they are considered to be quite efficient for ordinary circumstances.

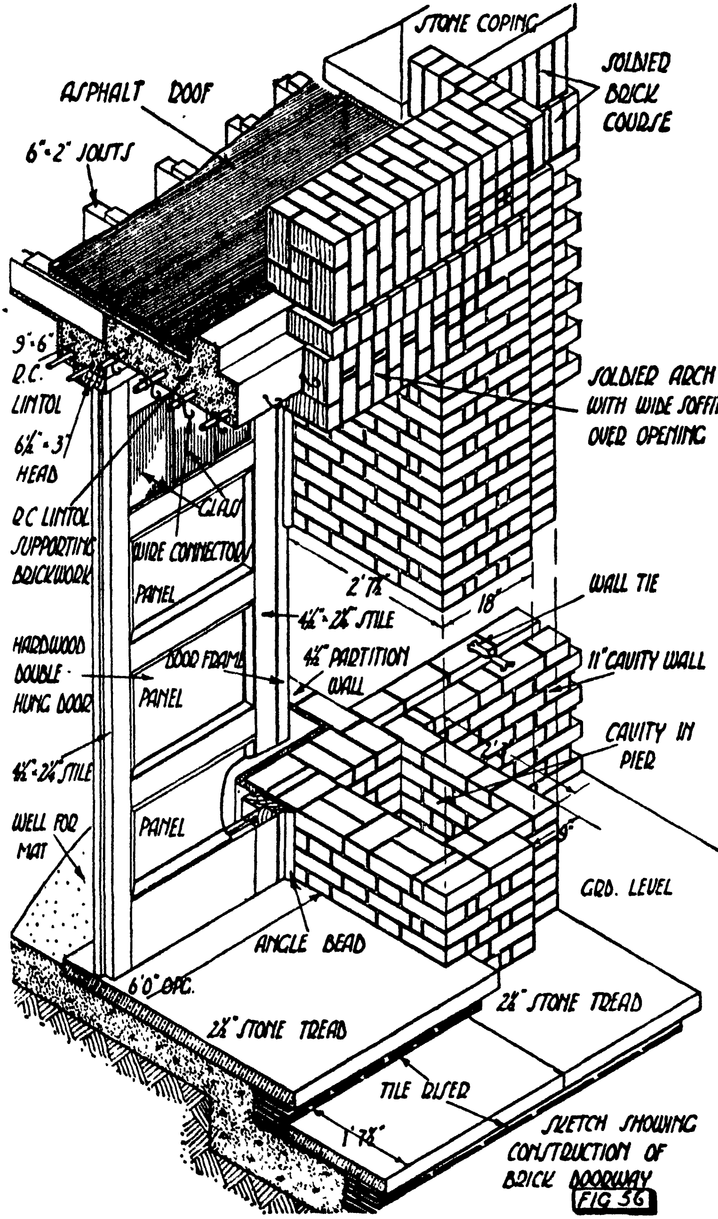
If specially designed pots are necessary, the construction and arrangement of the flues are at fault.

The pots should be securely embedded in brickwork set in Portland cement mortar, the latter being 'haunched' or 'flaunched' around the pots to assist in throwing off the rainwater.

Brickwork Details

Details illustrating various items in brickwork are given throughout this book, but particular attention should be given to the details of the Entrance Doorway to the Assembly Hall, illustrated in Figs. 52, 53, 54 and 55. Very pleasing effects in


PROJECTING BRICK KEY
STONE COPING
15"
15½"
END OF STONE COPING
6"·2" JOISTS
RAISED PANELS
4'0"
7'0"
7'6"
6"
ELEVATION
FIG. 52
SECTION
FIG. 53
COPING
2'3"
2'7½"
6'0" OPENING
ASPHALT ROOF
YORK STONE TREAD
9" 18"
PLAN THRO' DOORWAY
FIG. 54
PLAN ABOVE ROOF
FIG. 55.



SKETCH SHOWING CONSTRUCTION OF BRICK DOORWAY

FIG 56

brickwork can be obtained providing the bricks chosen for the work are suitable in regard to colour and texture, and the arrangement of the face bonding carried out in a proper manner. A sketch showing the construction of the Doorway is given in Fig. 56.

The flat arch over the doorway is supported on a reinforced concrete lintol, and the bricks which form the wide soffit of the arch, are suspended from the lintol by means of hangers, which are shown in the sketch. The projecting brick key may be formed *in situ* or the bricks pre-bonded and placed in position as a block.

CHAPTER VII

STRUCTURAL STEELWORK

It is not intended to deal with steel-framed structures in this chapter, but to give an outline of the structural steel shapes and simple steel connections, as steel-framed structures will be dealt with in Vol. III. Because it is necessary to introduce the principles of the construction of steel roof trusses and steel floor beams in this year's work, it is important that students should understand the elementary details relating to structural steel members.

Rolled Steel Shapes

The rolled steel shapes mostly employed in building construction are:

(1) I sections.
(2) Channel sections.
(3) Angle sections.
(4) Tee sections.
(5) Plates and flats.

Steel rods and various shaped bars are used as the reinforcing medium in concrete.

I sections (B.S.B.) commonly termed rolled steel joists or beams are the most common structural steel forms, they are economical in material and suitable for floor beams, lintols, stanchions, etc.

They are economical in material, because the metal is concentrated in the two flanges, where the bending stresses are the greatest.

The section comprises top and bottom flanges and a plate, termed the web, which connects the two flanges. A section through a R.S.B. is given in Fig. 57, and it will be

noticed that the bulk of the material is concentrated in the flanges.

The smallest section being 3″ × 1½″ × 4 lb. and the largest 24″ × 7½″ × 95 lb.

Channel Sections (B.S.C.), Fig. 57, are more generally used as members of steel-framed structures and not as independent members for the support of loads over openings.

They comprise two flanges and a connecting web, the latter being uniform in thickness with the flanges.

The smallest B.S.C. section obtainable is 3″ × 1½″ × 4·60 lb., and the largest 17″ × 4″ × 51·28 lb.

For the dimensions and properties of B.S.Bs. and B.S.Cs. reference should be made to the British standard specifications (B.S.S.) No. 4/1932.

Angle Sections (B.S.E.A.), or (B.S.U.A.), Fig. 57.—These are known as equal angles or unequal angles and used very considerably for connecting rolled steel beams and joists and for the component parts of steel roof trusses, also they are used in connection with concrete and filler-joist floors, where they are riveted to the web of the rolled steel floor beam, so as to provide the seating for the ends of the filler joists, as shown in Fig. 72.

The smallest B.S.E.A. obtainable is 1″ × 1″ × ⅛″, and the largest 8″ × 8″ × ⅞″.

The smallest B.S.U.A. is 2″ × 1½″ × $\frac{3}{16}$″, the largest being 8″ × 6″ × ¾″.

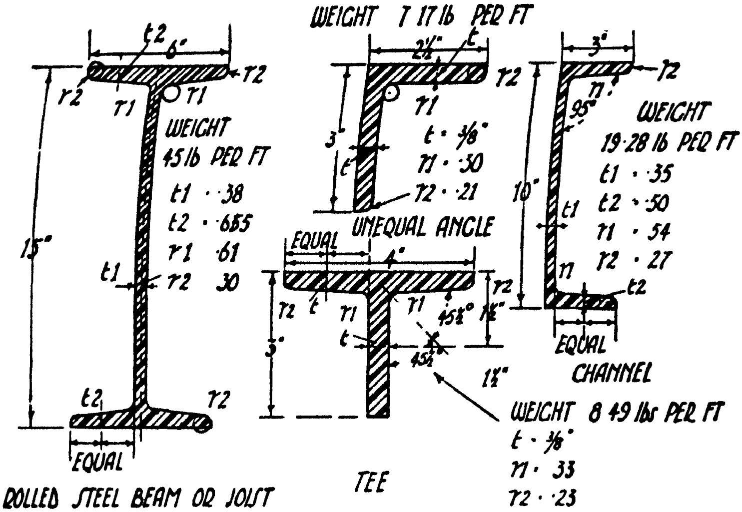
Tee Sections.—British Standard Tee bars (B.S.Ts.) Fig. 57. These sections are used as component parts of steel roof trusses and as the reinforcing medium in concrete lintols, etc.

The sizes range from 1½″ × 1½″ × ¼″ to 6″ × 6″ × ⅝″.

For dimensions and properties of B.S.As. and B.S.Ts. reference should be made to B.S.S. No. 4*a*(1934).

Plates and Flats.—These sections are used for many purposes in structural steelwork such as tensional members for steel roof trusses and for jointing purposes when increasing the length of rolled steel beams, also as a means for increasing the material in the flanges of rolled steel beams.

Plates are rolled in thicknesses varying from ¼″ to 2″.



STANDARD STEEL SECTIONS FIG 57

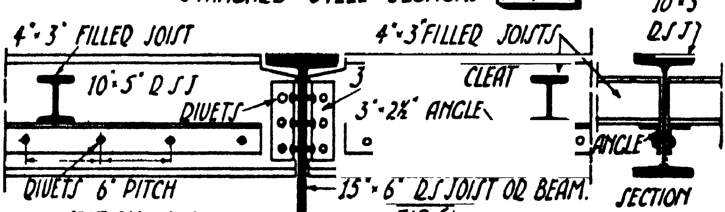
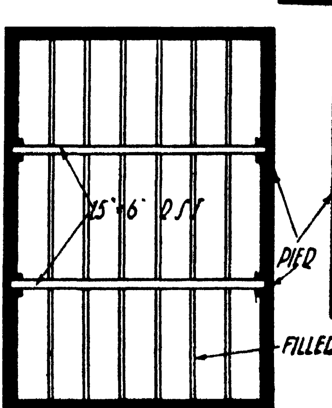
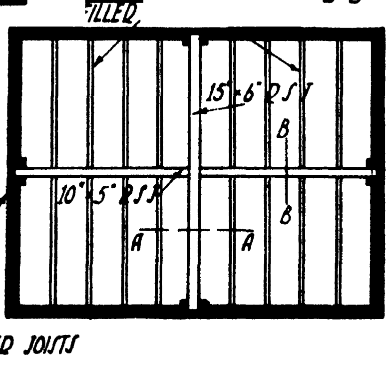


FIG 60



PLAN OF DOUBLE FLOOR FIG 58



PLAN OF FRAMED FLOOR FIG 59

Riveted Connections

The various connections in structural steelwork are usually made by riveting or bolting the members to one another, but the process of welding is becoming more generally adopted and is in many instances taking the place of riveting. For particulars regarding the riveting and bolting of steelwork reference should be made to B.S.S. 449. Rivets are generally manufactured from round rods of mild steel, one end being formed in the shape of a hemispherical button and a shank, which is cut to the length required.

Holes are drilled in the steel members to be connected, and the rivets, after being heated, are inserted in the holes and a second head formed on the end of the shank by means of a pneumatic hammer.

This process tightens the connection and renders the joint effective.

Fig. 60 is a detail of a riveted joint connecting three R.S. floor-beams.

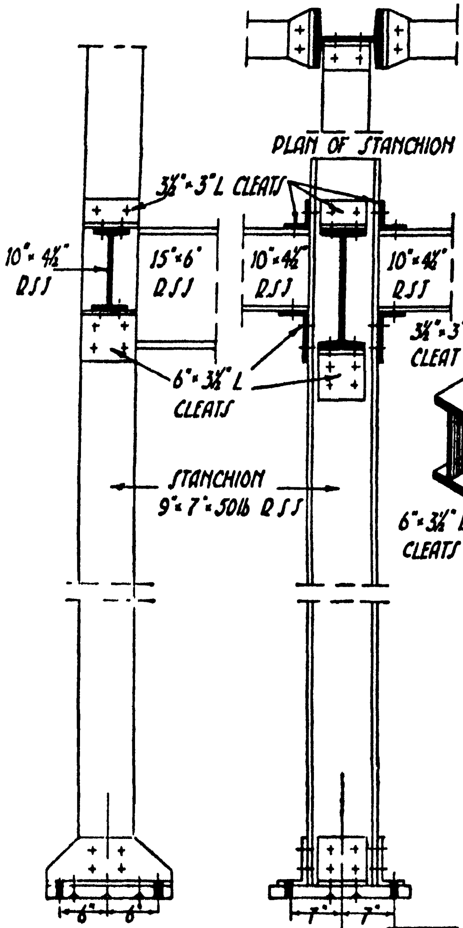
Details of riveted connections between a steel stanchion and steel floor-beams are given in Figs. 61 and 63. The distance between the centres of consecutive rivets is called the " pitch " and may be measured longitudinally or diagonally.

Steel Stanchions

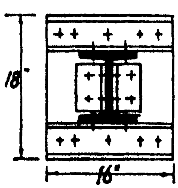
The term stanchion is applied to vertical steel sections of any shape other than those which are circular in section, and are intended as compressive members.

Their function is to transmit the loads from the floors and roof to the foundations.

The loads which are transferred from a stanchion to the concrete foundation must be spread over a larger area than the section of the stanchion, because the allowable unit compressive stress in steel is much greater than the ultimate compressive stress in concrete. To allow for this it is necessary to build out the lower end of the stanchion to form a base. A typical stanchion base is shown in Figs. 61, 62 and 63.



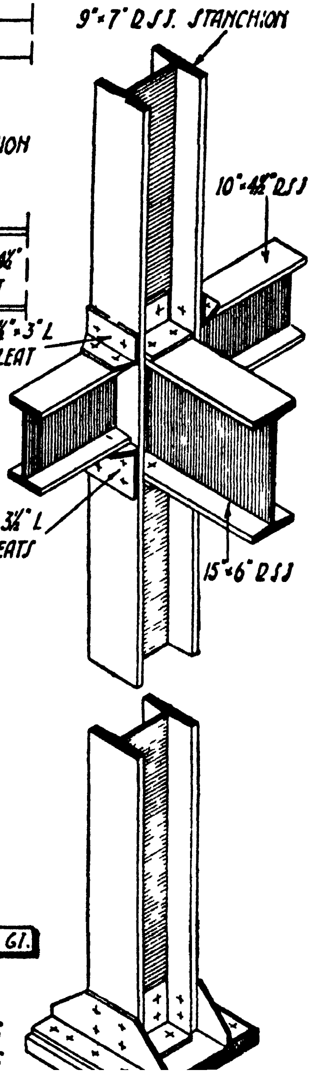
ELEVATIONS OF STANCHION FIG 61.



PLAN OF BASE FIG 62

MATERIAL IN BASE

1 16"×18"×1½" PLATE
2 6"×4"×⅝" Ls 16" LONG
2 6"×4"×⅝" Ls 6" LONG
4 1" DIA HOLES FOR ¾" BOLTS
8 ¾" DIA RIVETS COUNTERSUNK



SKETCH OF STANCHION SHOWING CONNECTIONS

It will be noticed that the effective compressive area has been increased from 9" × 7" to 18" × 16". The base is formed by connecting angle sections to the stanchion and to a steel base plate. There are various forms of stanchion bases but these will be dealt with in Vol. III.

CHAPTER VIII

CONSTRUCTION OF FLOORS

THE fundamental object of floors is to carry the inmates of a building together with their possessions. If the building is only one storey high, it is possible to support the floor upon the ground, but if a basement is required, or if the building is more than one storey high, some other means must be found for supporting the floors.

Floors can be classified in a general way as:

(1) Basement floors.
(2) Ground floors.
(3) Upper floors.

Basement Floors

In the case of basement floors, or ground floors resting immediately upon the ground, the vital consideration is the elimination of dampness. If the ground is fairly dry and well drained the earth can be excavated for some distance below the level of the concrete floor-slab and replaced with broken brick, which is termed hard-core.

Wherever possible the earth adjacent to the outside walls should be removed and an open area constructed as illustrated in Figs. 13 and 14.

Where there is a head of water, an upward pressure is exerted, therefore it is necessary to resist this pressure by reinforcing the concrete floor slab with steel rods or expanded metal.

Concrete floor slabs for basement floors should be constructed in two distinct layers, the lower slab being formed direct upon the hard-core filling and a two-ply layer of mastic asphalt spread over the top surface of the concrete slab and made continuous with the D.P.C. in the walls.

A top slab of concrete may then be placed on the asphalt so as to form the base for the floor finishings. The construction of a basement floor is illustrated in Figs. 9 and 15.

Ground Floors

Concrete Floors.—The most economical form of ground floor is one constructed of concrete laid on solid ground, the construction and finish being similar to that already described for basement floors and termed a solid ground floor.

Details showing the construction of solid ground floors are given in Figs. 27 and 28.

Timber-joisted Floors.—The construction of timber-joisted ground floors was discussed in Vol. I, but a sketch showing the construction of such a floor in connection with a fireplace opening is given in Fig. 47.

Timber-joisted Upper Floors.—Timber is still being used very considerably for the construction of upper floors in domestic buildings. This material is cheap and easily erected and fulfils the requirements of good floor construction. Details of the construction of a timber upper floor are given in Fig. 47.

Floor Finishings

The floor finishings may consist of boards laid on battens and secured to the concrete by nailing or by means of patent clips.

The timber used in the construction of boarded basement floors should be creosoted before being placed in position, and the space under the boards ventilated by being connected with air ducts, situated in the surrounding walls.

When wood blocks form the floor finishing, the concrete surface should be screeded to a level surface with Portland cement mortar and the blocks laid direct on the screed after the surface has been covered with a bitumastic emulsion.

A cement mixture of one part Portland cement and two parts sand may be used for the floor finishings, if desired, or the finished surface may be formed with 6″ square quarry tiles laid in Portland cement mortar as shown in Fig. 199.

Jointless Flooring

The finished floor surface may be formed by the application of one of the many patent magnesite flooring compounds which are obtainable.

For particulars of these jointless flooring compounds reference should be made to B.S.S. No. 776 (1938).

Rubber Tiles

Rubber in the form of tiles, may be used for floor finishings. The top surface of the concrete floor-slab is screeded level with Portland cement mortar and when this is thoroughly dry the tiles are secured to the cement screed by specially prepared rubber adhesives.

Double Boarding

In special circumstances, such as the floor in the Assembly Hall, or where the floor may be used for various purposes, and where hard-woods are preferred, the flooring may comprise a double layer of boards.

The boards comprising the sub-floor are usually placed diagonally across the battens, and the finished floor-boards laid with their length at right angles to the battens.

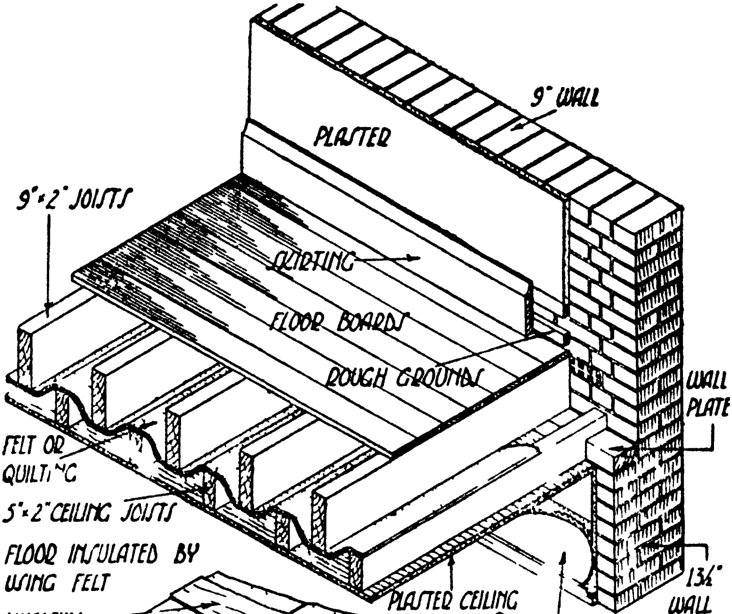
The hard-wood boards for this type of flooring should be rebated, grooved and tongued, so that the fixing nails may be driven through the angle of the tongue, thus producing a form of secret-nailing.

The top layer of boards is usually laid after the internal plasterwork is finished.

Insulation of Timber-joisted Floors

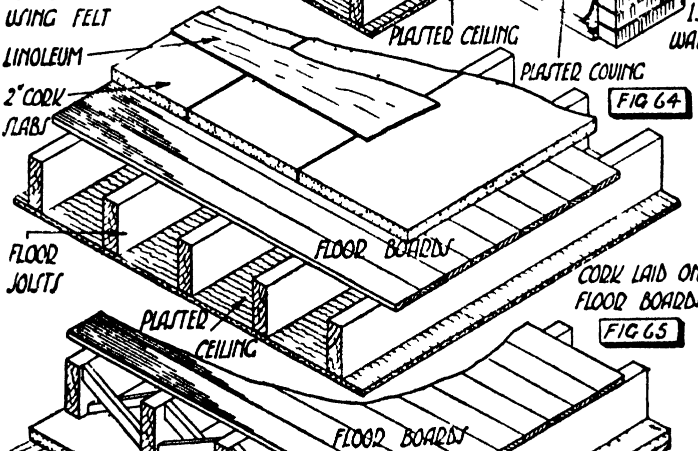
All floors may be sound insulated by including various sound-proofing materials in their construction. Contact noises are transmitted by floors and result from people walking over and dropping articles on the floor.

Timber-joisted floors may be insulated by incorporating a layer of insulative material in the construction of the structural



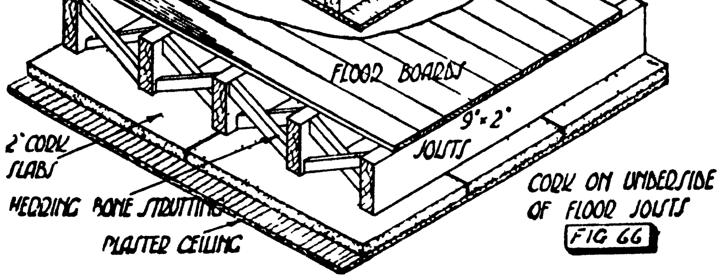
FLOOR INSULATED BY USING FELT

FIG 64



CORK LAID ON FLOOR BOARDS

FIG 65



CORK ON UNDERSIDE OF FLOOR JOISTS

FIG 66

floor, or by applying the material to the top or the under surface of the joists.

Felt Interlay

The construction shown in Fig. 64 consists of an underlay of felt or quilting, placed between the underside of the floor-joists and the top surface of ceiling joists, which are placed in a staggered position in relation to the floor-joists.

Cork-board

In Fig. 65 slabs of cork-board are shown laid upon the floor-boards and secured to these with galvanised wire nails.

Another method is shown in Fig. 66, but in this example the cork-board is secured to the underside of the floor-slabs and the plaster work of the ceiling formed on the surface of the cork slabs. When used in this position it is preferable however to cover the cork-board with wire-netting before the plasterwork is applied, thus ensuring an effective key.

CHAPTER IX

STEEL AND TIMBER FLOORS

STEEL and timber are often combined in the construction of floors which cover a large area.

Single Floors

A floor which spans a compartment with the use of one series of joists is termed a 'single floor.'

Double Floors

When the span is too great, one or more beams are introduced, thus dividing the area into two or more bays as shown in Fig. 58. This type of floor is termed a 'double floor,' and when the beams are of timber they are termed 'binders.'

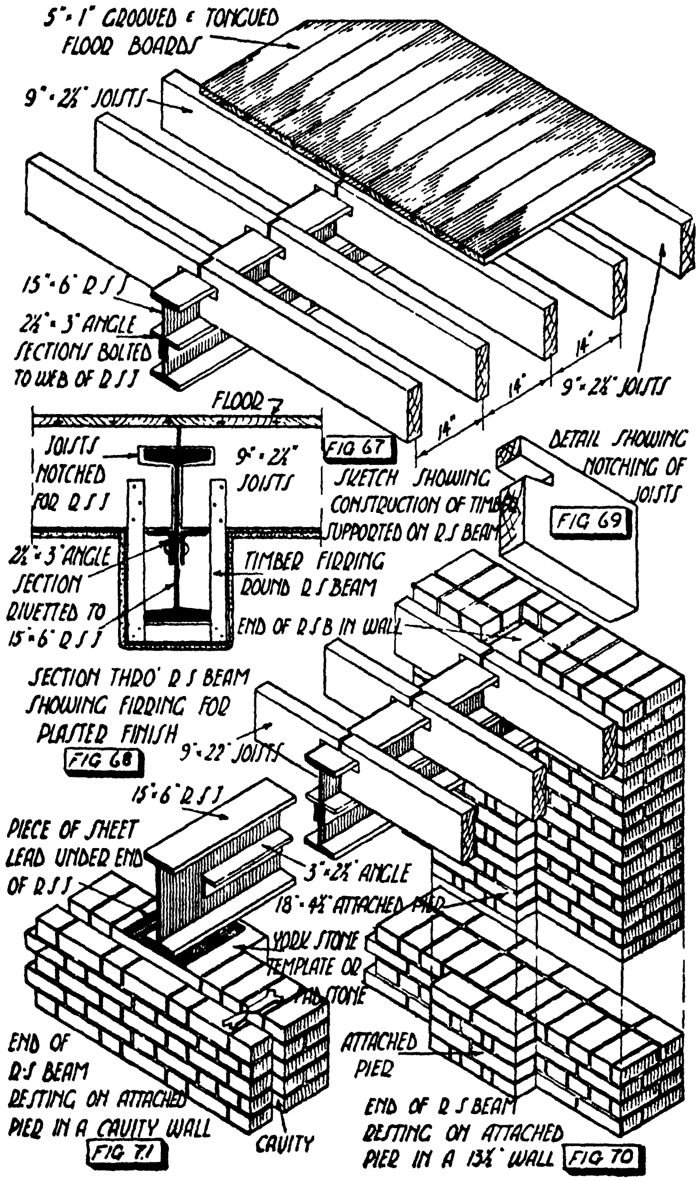
The use of timber beams or 'binders' in floor construction is now almost entirely superseded by R.S. Beams, into which are framed the timber floor-joists which support the flooring, as shown in Figs. 67–70.

Framed Floors

Larger floor areas are sub-divided into bays by introducing secondary beams placed at right angles to and connected to the main beams, as shown in Fig. 59. This type of floor is termed a 'framed floor.'

The floors illustrated in Figs. 67–70 show the joists trimmed to rest upon angle sections which are riveted to each side of the web of the rolled steel beam, the lower portion of the beam extending below the ceiling level.

It is usual to fir-out the projecting portion of the beam with pieces of timber to form a ground or fixing for the plasterwork, as shown in Fig. 68.


5" × 1" GROOVED & TONGUED FLOOR BOARDS
9" × 2½" JOISTS
15" × 6" R S J
2½" × 3" ANGLE SECTIONS BOLTED TO WEB OF R S J
14"
14"
14"
9" × 2½" JOISTS
FLOOR
JOISTS NOTCHED FOR R S J
9" × 2½" JOISTS
FIG 67
SKETCH SHOWING CONSTRUCTION OF TIMBER SUPPORTED ON R S BEAM
DETAIL SHOWING NOTCHING OF JOISTS
FIG 69
2½" × 3" ANGLE SECTION RIVETTED TO 15" × 6" R S J
TIMBER FIRRING ROUND R S BEAM
END OF R S B IN WALL
SECTION THRO' R S BEAM SHOWING FIRRING FOR PLASTER FINISH
FIG 68
9" × 22" JOISTS
15" × 6" R S J
PIECE OF SHEET LEAD UNDER END OF R S J
3" × 2½" ANGLE
18" × 4½" ATTACHED PIER
YORK STONE TEMPLATE OR PAD STONE
END OF R S BEAM RESTING ON ATTACHED PIER IN A CAVITY WALL
FIG 71
CAVITY
ATTACHED PIER
END OF R S BEAM RESTING ON ATTACHED PIER IN A 13½" WALL
FIG 70

Stone Templates

The ends of the R.S. beam should rest on stone templates or padstones which are intended to assist in distributing the loads of the floor over a larger area of the wall.

The steelwork sections for floor-beams should be correctly chosen and of sufficient length to allow the girder to rest on the padstones or templates and the size of the template should ensure that the brickwork is not subjected to too great compressive stresses.

The minimum thickness of stone templates should be equal to the maximum projection of the template on either side of the steelwork, which rests upon it. A stone template 18″ wide on face, carrying a R.S.J. 6″ wide, should have a minimum thickness of 6″.

CHAPTER X

CONCRETE FLOORS AND LINTOLS

THE modern practice in floor construction is to substitute concrete floors for timber floors. This change has been largely brought about by the desire to render buildings more fire-resisting and also by the advent of framed structures.

Although no building material can be said to be absolutely fire-proof, yet with careful choice of suitable materials, buildings can be constructed so as to be reasonably fire-resisting.

As the vertical spread of fire depends to a very large extent upon the fire-resisting properties of the floors, it is only natural that the use of timber should be discontinued in favour of those materials known to have better fire-resisting qualities.

There are many types of fire-resisting floors, but it is not intended to describe them in this volume as they come within the scope of the work intended for the third year course.

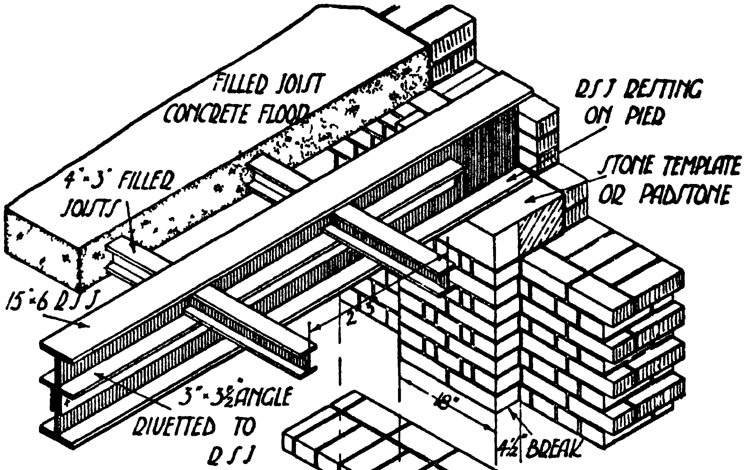
Concrete and Filler-joist Floors

The construction of concrete and filler-joist floors was usually carried out with coke breeze concrete in which small rolled steel sections were embedded.

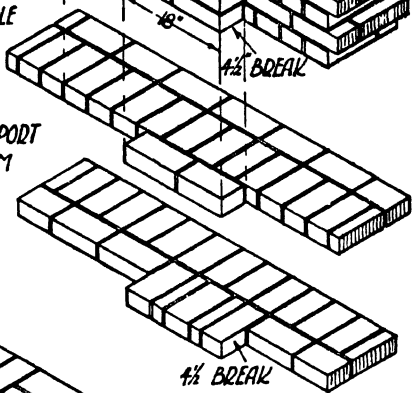
It is now usual to use crushed brick aggregates for the concrete; or if a light-weight concrete is desired, slag or crushed clinker may be used. The floors are formed by spanning the area to be covered with small R.S.Js. placed about 2–3″ apart, centre to centre, and filling the spaces between and around the joists with concrete.

The small R.S.Js. are supported on an angle section connected to the web of the main floor-beam or they may be supported on the walls. The floor-beams should be concreted at the same time as the floor-slabs are formed.

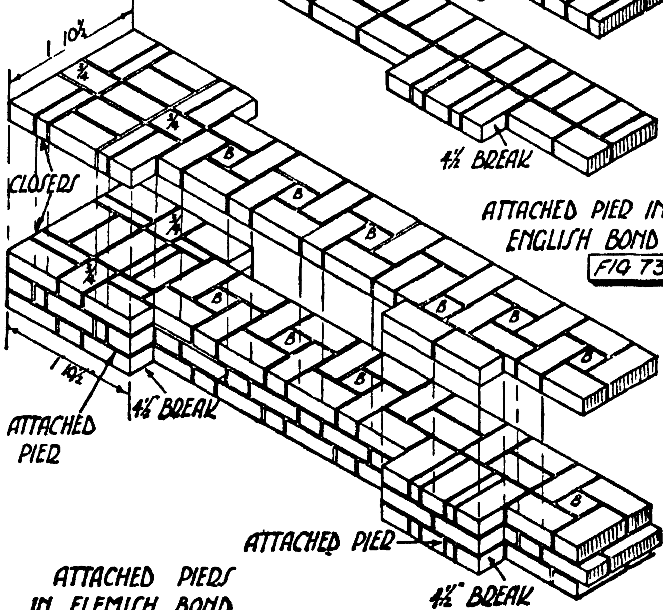
A sketch showing the construction of the concrete and filler-joist floor over the heating chamber of the Assembly Hall is



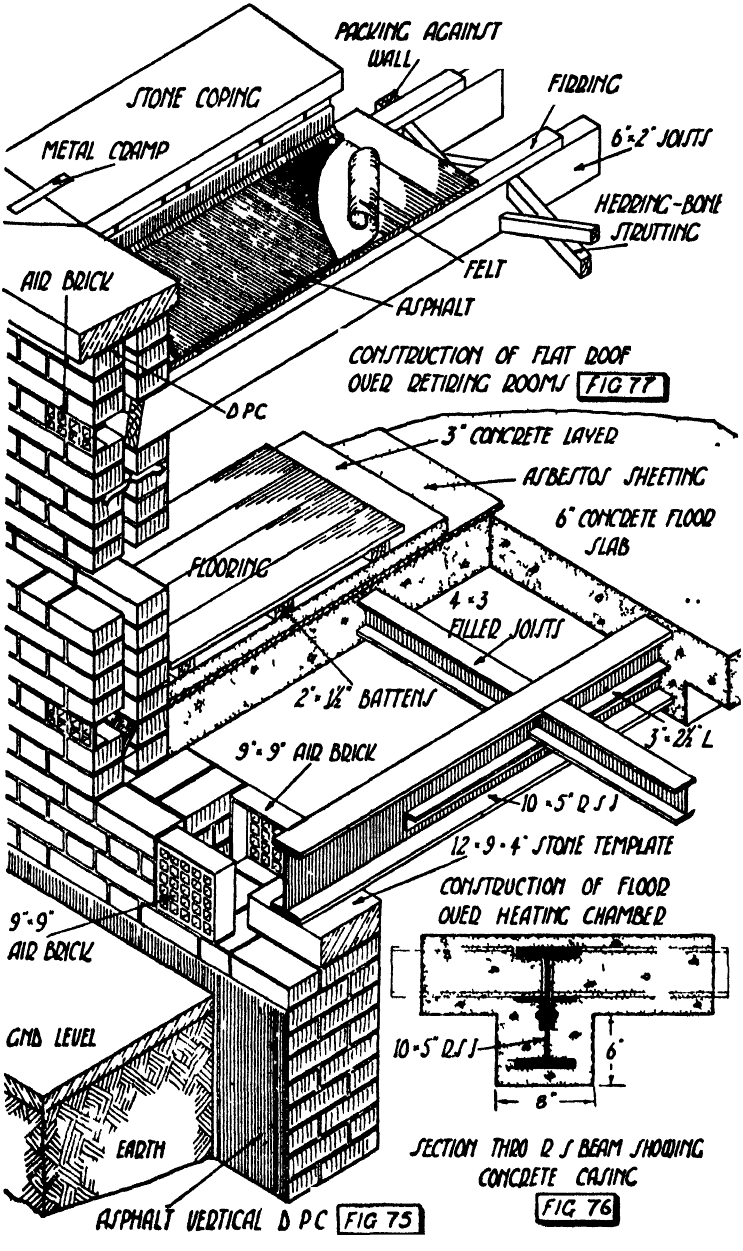
SKETCH SHOWING SUPPORT FOR STEEL FLOOR BEAM
FIG 72.



ATTACHED PIER IN ENGLISH BOND
FIG 73



ATTACHED PIERS IN FLEMISH BOND
FIG 74



CONSTRUCTION OF FLAT ROOF OVER RETIRING ROOMS FIG 77

CONSTRUCTION OF FLOOR OVER HEATING CHAMBER FIG 75

SECTION THRO R S BEAM SHOWING CONCRETE CASING FIG 76

given in Fig. 75, and Fig. 81 shows the centering and shuttering necessary for supporting the concrete floor-slab and beam-casing during the process of constructing the floor.

Reinforced Concrete Lintols

It is not intended to deal with reinforced concrete structures in this volume, but to confine the notes to the elementary principles connected with the insertion of steel reinforcement in concrete lintols, etc., to take the tensional stresses.

It is common knowledge that when a beam supported at each end is loaded, there is a tendency for the beam to bend.

The fibres in the upper part of the section of the beam are in compression, whilst those in the lower half are in tension and the greatest stresses occur at the extreme top and bottom of the section.

As concrete is weak in resistance to tensional stresses, the steel bars should be placed in the concrete in positions where these stresses occur.

It is essential that the adhesion between the concrete and the steel be thorough, so as to prevent any slipping between the two materials, as this would cause the concrete to be subjected to tensional stresses.

As the maximum tensional stresses occur at the lowest part of a beam, the reinforcing bars should be placed as near as possible to the bottom of the lintol (which is another term for beam), and the ends of the rods turned up, or hooked, to assist in resisting any slipping tendency.

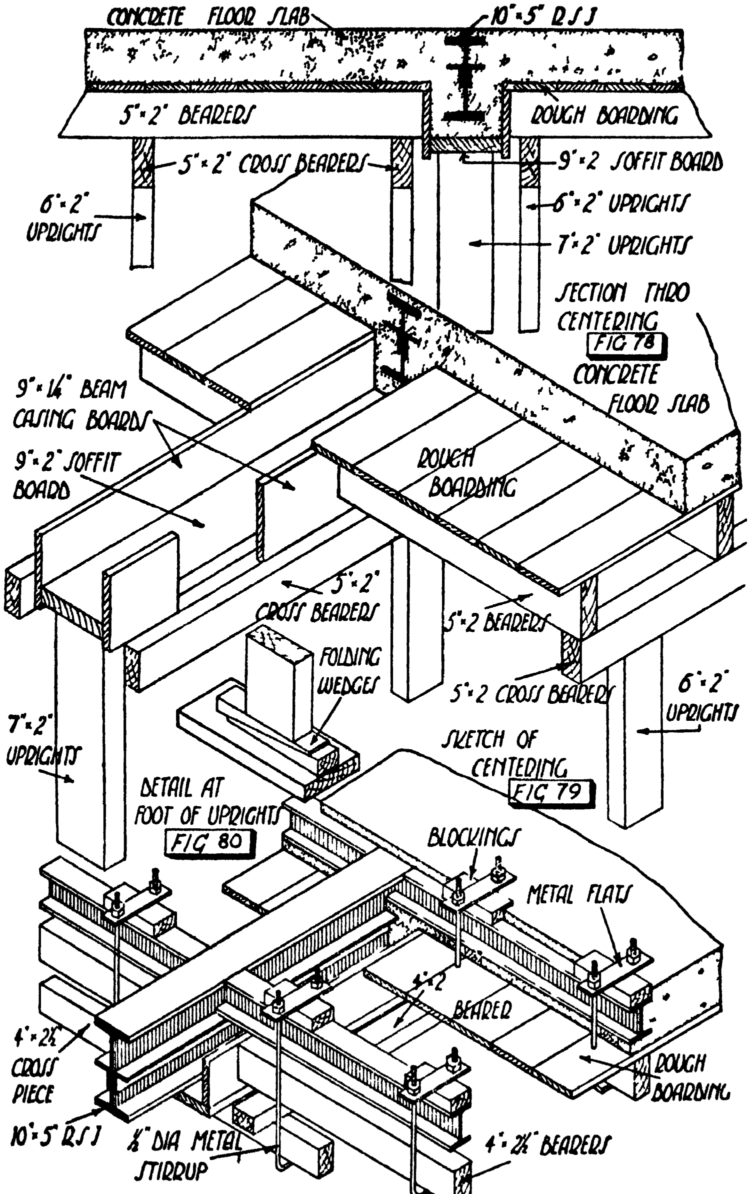
Sufficient room only should be allowed for the covering of the reinforcement bars by the concrete.

It is common practice to use steel rods as the reinforcing medium for concrete lintols, but other steel sections, such as Tee sections and small R.S.Js., are used sometimes.

Details of reinforced concrete lintols are given in Figs. 56 and 145.

Concrete Mixing

It is essential that concrete shall be placed in position as quickly as possible after it has been mixed and before its



SECTION THRO CENTERING FIG 78

SKETCH OF CENTERING FIG 79

DETAIL AT FOOT OF UPRIGHTS FIG 80

SKETCH OF SUSPENDED CENTERING FIG 81

initial set has taken place. For work entailing a large amount, it is preferable to mix the concrete in a machine mixer, because the degree, or extent of the mixing, is very variable when mixed by hand.

Uniformity in concrete-making depends on the proportions of cement, fine and coarse aggregates, and water, and all these factors are affected by the degree to which the mixing has been carried out.

Tests show that the strength of concrete is increased by longer periods of mixing and thorough mixing makes a more uniform concrete.

The strength of concrete depends very largely on the ratio of the volume of concrete to the volume of mixing water, and accurate mixing of all the ingredients is essential if its strength is to be constant throughout the different parts of a structure.

The cement should conform to the British Standard Specifications for Portland cement No. 12 (1931) (add. 1932). Aggregates should consist of inert materials that are clean, hard and durable, and graded, such as ' coarse ' or ' fine.'

A coarsely graded aggregate may require a higher proportion of cement than one which is finely graded, if the same degree of workability is desired.

The maximum size of the aggregates is usually governed by the nature of the work in hand, but their selection is ruled by the materials which are readily obtainable.

CHAPTER XI

SHUTTERING FOR CONCRETE LINTOLS AND FLOORS

THE larger portion of shuttering or formwork for concrete work is constructed of timber, but steel forms are used in many instances, particularly for the construction of concrete walls.

The shuttering for lintols and floors should be braced sufficiently and strutted so that deflection and distortion are reduced to the minimum amount under the load of its own weight, and that of the concrete.

It should be constructed in a manner that will facilitate its removal without damage to the concrete, and also permit of the members being stripped, so that the loads are taken by the structural members in rotation.

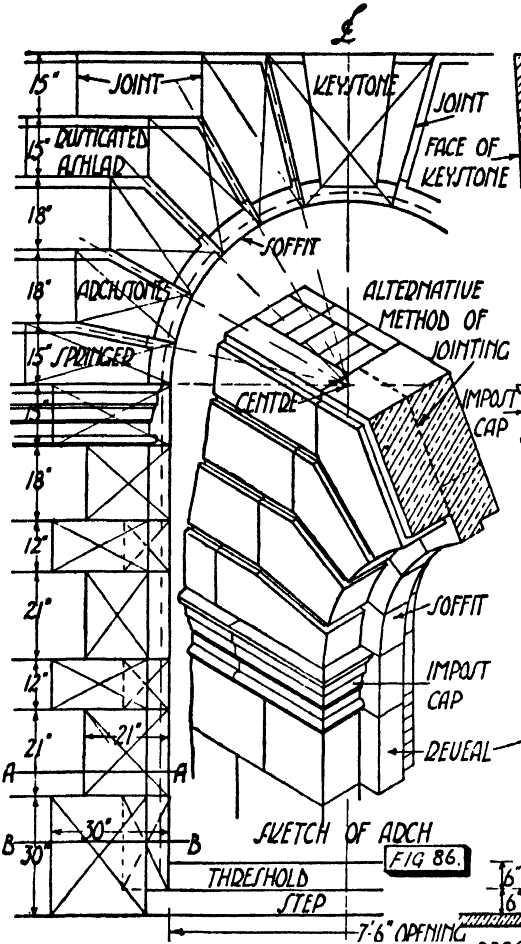
Shuttering for Lintols

The shuttering for concrete lintols may be constructed as shown in Figs. 87–90.

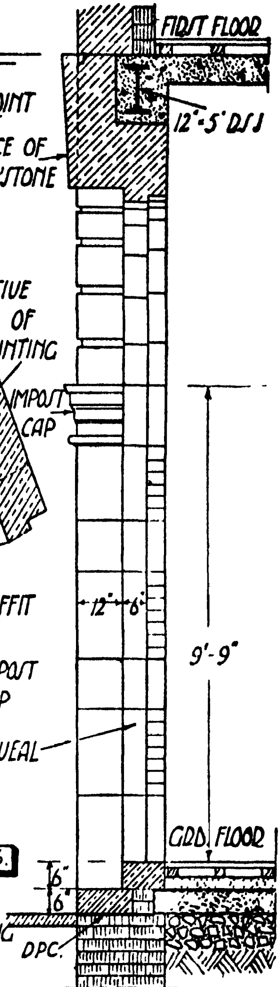
The boarding on the face of the lintol is cross-battened at frequent intervals, and continued down to the bottom edge of the soffit boarding so that the former can be removed without interfering with the soffit boarding. Timber uprights are placed at frequent intervals throughout the length of the soffit boarding and folding wedges may be placed under the uprights, or between the soffit boarding and the top of the uprights, as shown in Fig. 90.

When lintols are situated behind stone facings, and the concrete is to act as a covering for structural steelwork, the side sheeting may be held in position by fixing timber or metal stays across the top of the lintol, as shown in Figs. 87 and 90.

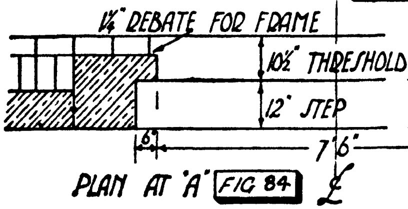
The timber used for shuttering is mostly rough sawn, but dressed or planed timber is frequently used for work of a special character.



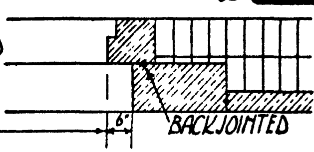
ELEVATION OF STONE SEMI-CIRCULAR ARCH FIG 82



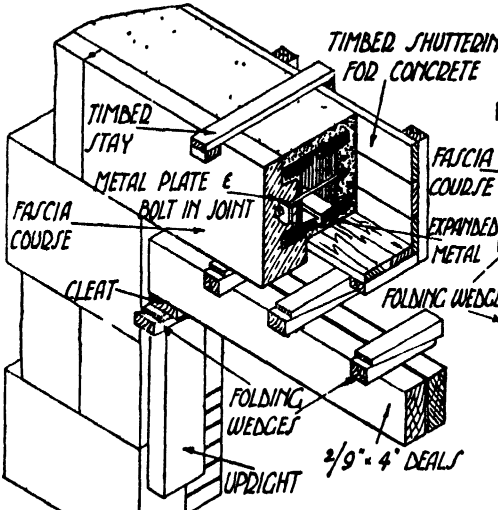
SECTION ON ℄ FIG. 83



PLAN AT "A" FIG 84 ℄

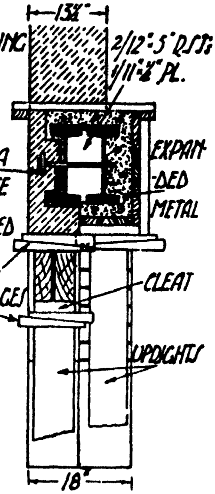


PLAN AT "B" FIG. 85.



SKETCH OF TIMBER CENTERING FOR STONE FASCIA

FIG 87



SECTION

FIG 88

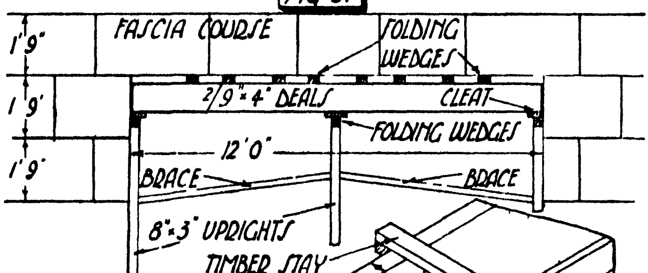
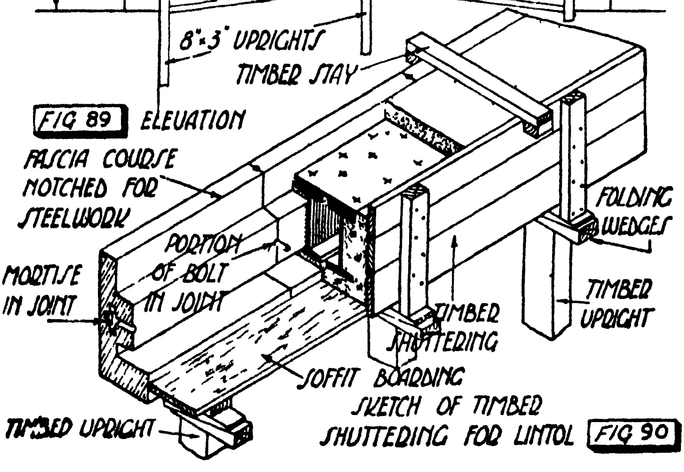


FIG 89 ELEVATION



SKETCH OF TIMBER SHUTTERING FOR LINTOL

FIG 90

Sizes of Timber

The thickness of the boards will depend upon the available supply, and on the loads to be carried, but usually they are from 1" to 2" thick. Square-edge boards are commonly used, but they may be tongued and grooved if desired.

Posts and uprights range from 4" × 3" to 6" × 6".

Shuttering for Concrete Floors

The shuttering for the temporary support of concrete and filler-joist floors, may consist of boarded sheeting supported on bearers which in turn are held in position by uprights or posts and strutted from the floor below, as shown in Figs. 78 and 79. The bearers and props may be any size from 4" × 2" to 9" × 3", but for ordinary purposes 6" × 2" timbers are commonly used.

Suspended Shuttering for Concrete Floors

In some instances the sheeting is suspended from the structural steelwork by metal straps and hangers, placed across the top of the structural steel members. Bolts are passed through the concrete floor, and these are connected to lower metal straps placed under the timber bearers, or metal stirrups may be used as shown in Fig. 81. The advantages claimed for this type of construction are :—

(1) A clear space is allowed under the floor during the process of constructional operations.

(2) A great reduction in the amount of timber.

(3) Economy in timber wastage occasioned by the varying heights of the floors.

If uprights are to be used for the support of the shuttering it may be advisable to use one of the many forms of adjustable props, as these may be obtained in lengths covering the majority of heights required.

Beam Shuttering

When constructing the shuttering around beams it is advisable to use a thicker type of boarding for the soffit portion of

the beam, so that, providing the propping is adequate, any tendency to sag with the weight of the wet concrete may be prevented. The side boarding should be fixed so that it can be removed without interfering with the soffit boarding, and as soon as the concrete is set and able to support its own weight.

The object of this procedure is to expose the side surfaces of the concrete to the air.

Details of beam shuttering are shown in Figs. 78 and 79. When props or uprights are used they should stand on sill pieces and folding wedges as shown in the detail in Fig. 80.

Striking Shuttering

The length of time which should elapse before the shuttering is removed will depend on the type of member strutted and the kind of cement used.

When ordinary Portland cement concrete is used a period of 14 to 20 days should be allowed, but for rapid hardening Portland cement concrete a period of from 4 to 7 days is usually sufficient. The removal of the shuttering must be carried out slowly and without undue vibration as the sudden removal of wedges is equivalent in its effect to dropping a heavy load on the partly set concrete. Before any supports are removed it is advisable to inspect the concrete and test its hardness.

CHAPTER XII

STONE DRESSINGS

Ashlar is the term used for finely dressed stone which is worked to fit in the general face of a wall. It may be plain, rusticated, rock-faced, or chisel-drafted and described according to the detail of the finish. Details of the stone dressings for a main entrance doorway are given in Figs. 82–86.

This example shows plain ashlar facings and jambs extending up to the Impost Cap, the top bed of which is situated at the springing level of the arch.

Impost Cap

An impost cap may be defined as the capital of a pier or pilaster which receives an arch, and is usually a moulded course situated at the springing of an arch, its character varying in the different Orders of Architecture.

Semi-circular Stone Arch

The opening shown in Fig. 82 is covered by a semi-circular arch, the voussoirs of which are rusticated to suit and bond with the surrounding rusticated ashlar courses.

The arris lines of the rustication recesses at the joints of the voussoirs should be parallel, and not converging to the centre of the arch, the width of the recesses being set out from centre lines, as shown by dotted lines in elevation.

A sketch showing the finish of the rustication recesses where they occur against the face of the arch rebate, is given in Fig. 86.

Fascia Courses

A fascia course is a sub-division of an Architrave that is part of an Entablature, but the term fascia is generally applied to the horizontal course of stones over a wide opening.

In modern construction, the stones comprising these courses *are supported on and attached to* steelwork, and although *they may assume the aspect of solid stones, they are really* a veneer or covering to the structural and load-carrying member.

Rolled steel beams of a section suitable to carry the calculated load are placed across the opening and the stones are notched for and bolted to the steelwork.

Metal Connections

Galvanised iron plates threaded on bolts are often used as the mechanical device for connecting stonework to steelwork.

A mortise for half the plate is cut in the joint surface of each stone, and into this mortise, the plate is inserted; the bolt passing through the web of the steel joist is tightened by means of the threaded nut at the other end of the bolt, as shown in Figs. 95 and 96.

Figs. 87 and 88 show a similar piece of construction, but in this example the bolt passes through the webs of twin R.S.B.'s.

The stones comprising the fascia course must be placed in position and bolted to the steelwork before the concrete casing is placed round the steelwork.

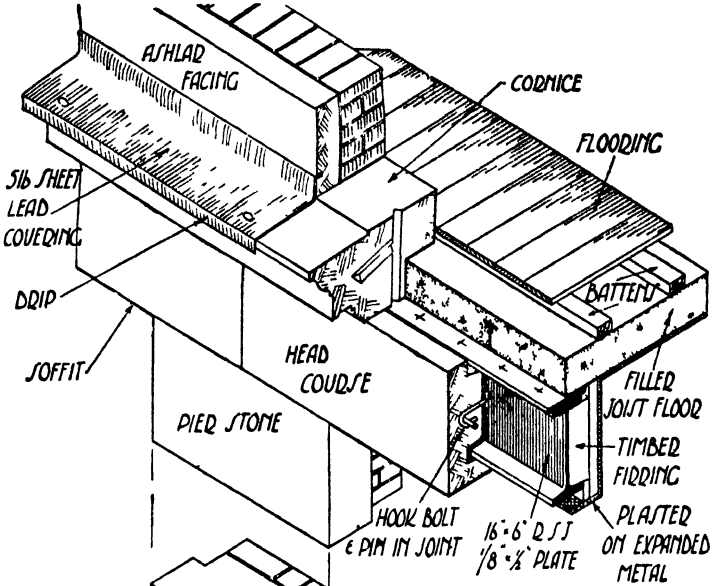
Another form of connecting device, combining a hook-bolt and pin, is shown in Fig. 93.

Although somewhat similar to the device already described it is not so effective from a constructional point of view.

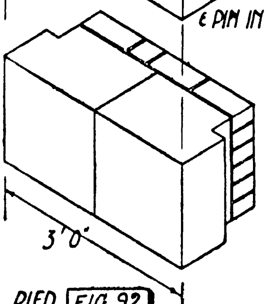
A sketch showing a hook-bolt and pin in position in the joint surface of a piece of stone which forms part of a fascia course is given in Figs. 91 and 94.

Certain building by-laws and regulations require all steelwork to be encased in concrete as a protection against damage in the event of an outbreak of fire, and when these regulations are in force, it is impossible to attach the stonework direct to steelwork.

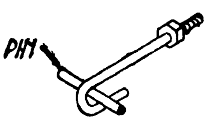
Figs. 97 and 98 show the construction of a fascia course attached to the concrete casing. When this method of attachment is adopted, it is advisable to insert a metal cramp across the top surface of the stones and the concrete, as shown in the sketch and provide for an anchorage to the concrete by



SKETCH SHOWING CONSTRUCTION OF STONE HEAD COUSE & CORNICE FIG 91



SKETCH OF PIER FIG 92



SKETCH OF HOOK BOLT & PIN FIG 93

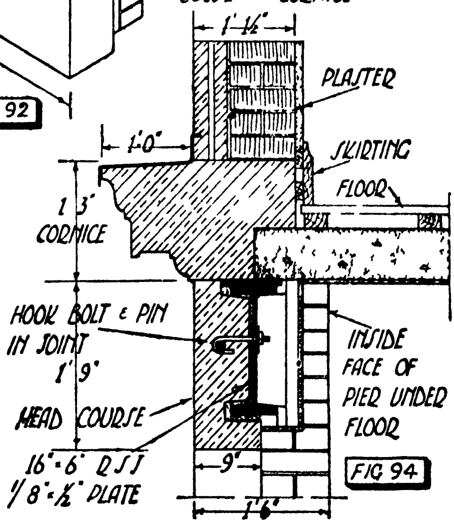
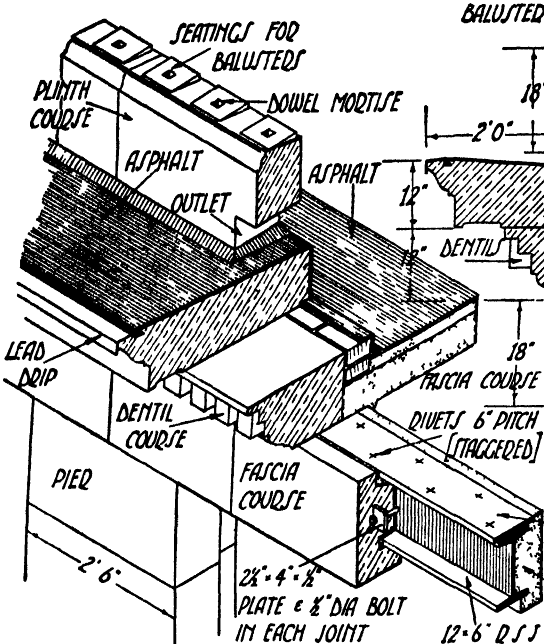
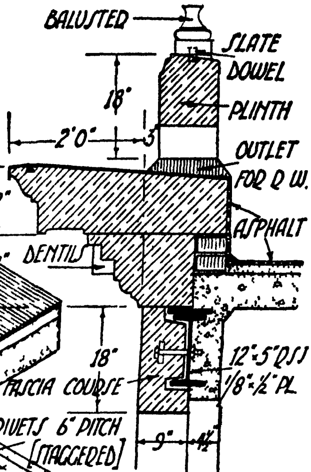


FIG 94

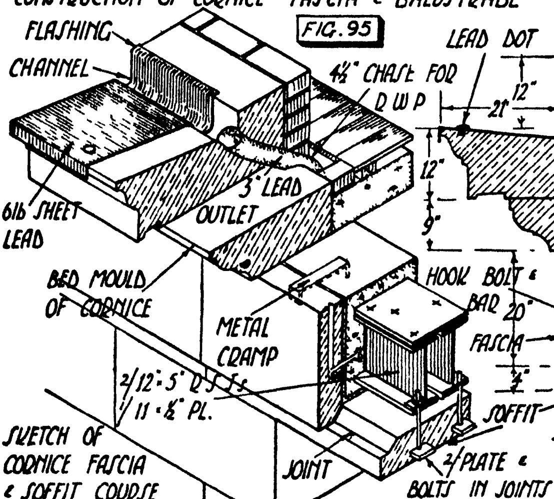


CONSTRUCTION OF CORNICE FASCIA & BALUSTRADE

FIG. 95

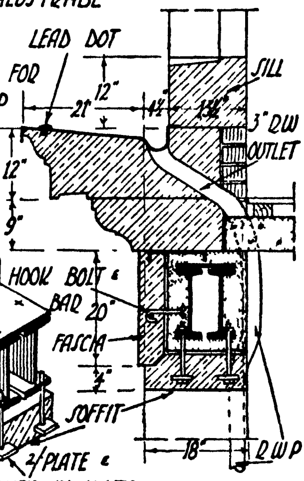


SECTION FIG 96



SKETCH OF CORNICE FASCIA & SOFFIT COURSE

FIG 97



SECTION FIG 98

inserting fish-tailed hook and pin bolts in the joint surfaces of the stones as shown in Figs. 97, 98.

Soffit Courses

When a wide soffit forms part of a fascia course, it is preferable to construct the soffit in separate stones, otherwise the stones will require an enormous amount of notching.

The course comprising the soffit is termed a soffit course and the stones in the course may be suspended from the bottom flanges of the R.S.B.s, as shown in Figs. 97 and 98.

It is advisable to utilise, if possible, the internal angle of a fillet for the bed-joint between the soffit course and the fascia course, as shown in the drawings. The stones are suspended from the steelwork by means of hanging plates and bolts which are inserted in the joints of the soffit stones, and passed through and connected to the bottom flanges of the steelwork before the concrete is placed in position.

Timber Centers for Fascia and Soffit Courses

The successful fixing of these courses requires the provision of rigid timber supports termed ' centers ' or ' head-trees.'

Figs. 87, 88 and 89 illustrate the construction of a ' head-tree ' for the support of a stone fascia course. The sizes of the timber and the number of struts or uprights will depend upon the width of the opening to be spanned and the weight to be carried.

The top surface of the ' head-tree ' should be fixed about $1\frac{1}{2}''$ below the soffit line, so that sufficient room is allowed for pairs of folding wedges to be placed on the ' head-tree,' these acting as a seating for the stones and to assist in their adjustment. The timber centering should remain intact until the erection of a building has advanced sufficiently to warrant their striking or removal.

Stone Cornices

Large stone cornices usually comprise a series of courses, the projecting portion of each course assisting in supporting the projecting stonework of the course above.

The construction of a stone cornice complete in height in one course of stones and notched to fit over the edge of the concrete floor slab is illustrated in Figs. 91 and 94.

When stone cornices are built-up in several courses, great care must be given to the position of the bed-joints, as much labour and material may be wasted by unsuitable placing.

Figs. 97 and 98 are details illustrating the construction of a stone cornice complete in two courses and situated at floor level and surmounted by a 13½″ wall.

The bed-joint between the courses is shown in its correct position and level with drip of the cornice.

Figs. 95 and 96 illustrate the construction of a stone cornice surmounted by a stone balustrade and situated at roof level.

The position of the bed-joint is at the top of the fillet immediately above the dentils.

Steelwork plays a very important part in the construction of stone cornices and very largely determines the manner of jointing and bedding.

In steel-framed structures, steel stanchions are built in the walls and their function is to receive the loads of the building and transmit them direct to the foundations.

Horizontal steel joists, termed stringers, are connected to the stanchions at about floor level, their function being to assist in supporting the floors, but they are also often intended to act as a counter-balancing medium for the support of the projecting stonework. No mechanical means for the support of cornices are shown in the illustrations in this book, apart from superimposed loads such as walls, etc., as the examples given are not intended to illustrate the methods of attaching stone cornices to steel and concrete framed structures.

Coverings to Cornices.—The top surface of the projecting stonework is weathered, or worked inclined to the horizontal, so that the rainwater which accumulates on the top surface may be removed quickly from the surface.

It is usual to cover the exposed top surfaces of cornices with an impervious material, and so protect the stones, which are all more or less porous.

Figs. 91 and 94 show a stone cornice covered with sheet

lead. The surface of the stone is worked inclined towards the nosing and one edge of the lead is dressed over the nosing to form a drip, the other edge being dressed into a flashing groove cut in the ashlar facing course, immediately above the cornice.

Most building by-laws require the top surfaces of cornices that project more than 15" over a public footway to be worked inclined towards the building, and provision must be made for the discharge of the rain-water, as shown in Figs. 97 and 98.

In this example a channel is formed in the top projecting surface of the cornice and the whole of the surface including the channel is covered with sheet lead, copper, or zinc.

A rain-water pipe which is housed in a chase formed in the back surface of the pier is connected to the covering at intervals along the channel and throughout the length of the cornice, for the conveyance and discharge of the rain-water.

Figs 95 and 96 show the top surface of a cornice worked inclined towards the wall-face, and outlets are provided between the plinth course of the balustrade and the top of the cornice, so that the rain-water may be discharged direct on to the roof surface.

The top surface of the cornice, including the outlets, are shown covered with mastic asphalt and a lead strip is placed along the nosing of the cornice and turned into a dovetailed groove to form an effective drip.

Sheet zinc or copper may be used instead of sheet lead for covering cornices if desired.

CHAPTER XIII

ROOF CONSTRUCTION

Timber Flat Roofs

THERE are many methods of constructing flat roofs with timber joists which are firred up with pieces of timber to the proper falls and covered with close boarding. But such roofs require to be finished in a manner that will exclude dampness and act as an insulating medium against heat and cold.

Flat roofs, whether constructed of timber or steel and concrete, are framed in a manner similar to floors. As floors are required to be covered with a series of finishing layers so should flat roofs be covered with a lasting, insulative and waterproof material.

The general planning of flat roofs should receive particular attention in regard to the direction of the joists and their relation to eaves and parapet walls. Timber joists should span the minimum distance between the bearings, and may be used for spans up to 18′ without intermediate supports, providing they are strutted or braced at frequent intervals so as to stiffen the joists laterally.

The distance apart of the joists may be 16″ to 18″, but it is advisable to reduce these dimensions to 14″ to 16″ if a lath and plaster ceiling is to be formed on the underside of the joists.

Flat Roof over Bay Window

The construction of a flat roof over a bay window is illustrated in Figs. 156 and 157.

One end of the bearers which support the roof finishings is trimmed into and rests upon rolled steel joists which span the opening, while the outer ends of the bearers are supported upon the head of the window-frame.

The inclination of the roof surface is obtained by fixing tapered firring pieces on to the top surface of the bearers and covering them with close boarding as shown in the sketch, Fig. 157.

In the case of wider roof surfaces it is preferable to arrange the boarding so that the length-way of the boards is parallel to the 'fall.'

To enable this to be done the firring pieces would be notched to suit the varying heights and fixed across the bearers instead of parallel as shown in the sketch. A detail showing the finish of the roof at the top of the window-frame is given in Fig. 160.

The ceiling is formed by blocking out the inside R.S.J.s and fixing firring pieces to these blocks for the support of the plasterwork.

Flat roofs of this description are best covered with sheet lead, zinc or copper, but for roofs of large area asphalt or one of the many bitumastic felts may be used more advantageously.

A detail showing the finish of the lead and the fixing for the C.I. gutter is given in Fig. 160.

Firring for Flat Roofs

The construction of the flat timber roof over the retiring rooms of the Assembly Hall is illustrated in Fig. 77.

The timber joists are laid level, and on top of each are fixed firring pieces which graduate in thickness towards the lowest part of the roof surface and to suit the required 'fall.'

The 'fall' usually allowed for flat roofs is $1\frac{1}{2}''$ to $2''$ in $10'$.

It is often desirable to place the roof boarding with their length in the direction of the fall, but this procedure often entails a good deal of extra labour in notching the firring pieces or using pieces of varying thickness when the direction of the joists is at right angles to the fall as shown in Figs. 99 and 100.

Ventilation

It is advisable to make provision for a reasonable current of air to circulate round the timbers, and this may be done by

inserting air bricks at an eaves or in the brickwork of the parapet wall, as shown in Figs. 99 and 100.

One of the advantages of using a system of counter firring is that the spaces between the firring pieces assist the circulation of air around the surfaces of the timbers.

Concrete and Filler-joisted Roofs

Flat roofs comprising concrete and steel are constructed in a manner similar to ordinary floors, but they are required to be screeded over the top surface of the concrete so as to obtain the correct falls in the direction required.

Flat Roof Coverings

Flat roofs of small area may be covered with sheet lead, copper or zinc, but for ordinary roofs of large area, it is preferable to cover them with mastic asphalt, finished in two plies and laid on roofing felt. For insulating purposes the asphalt may be covered with patent concrete tiles or gravel.

Zinc sheets may be considered the cheapest form of metal roof covering, but if they are laid in a proper manner their longevity is considerable.

For ordinary work 14 to 16 Z.G. should be used.

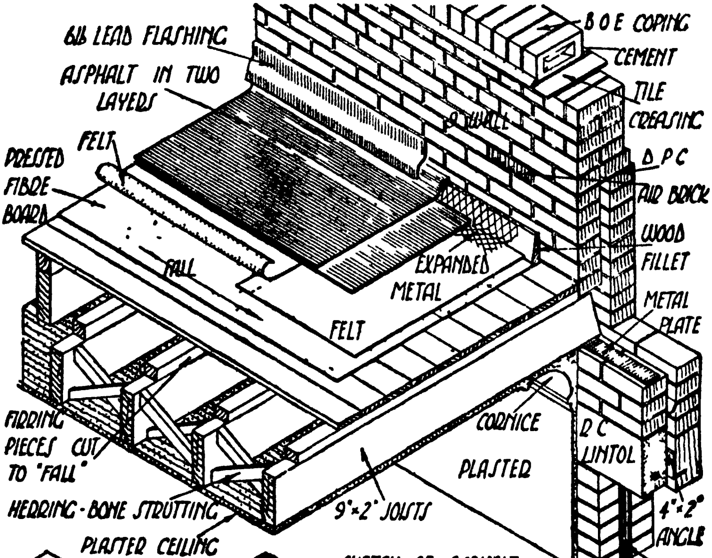
Sheet copper is often used for covering permanent structures of small area.

The sheets should be approximately 24 S.W.G.

Sheet lead is the most adaptable metal covering for flat roofs of small area owing to its pliability and capacity to be worked to any shape. When laid on timber-joisted roofs the boarded surface should be prepared to an even surface or covered with fibre sheets and roofing felt before the lead covering is applied; 5 to 6 lb. lead is usually adopted for roof work.

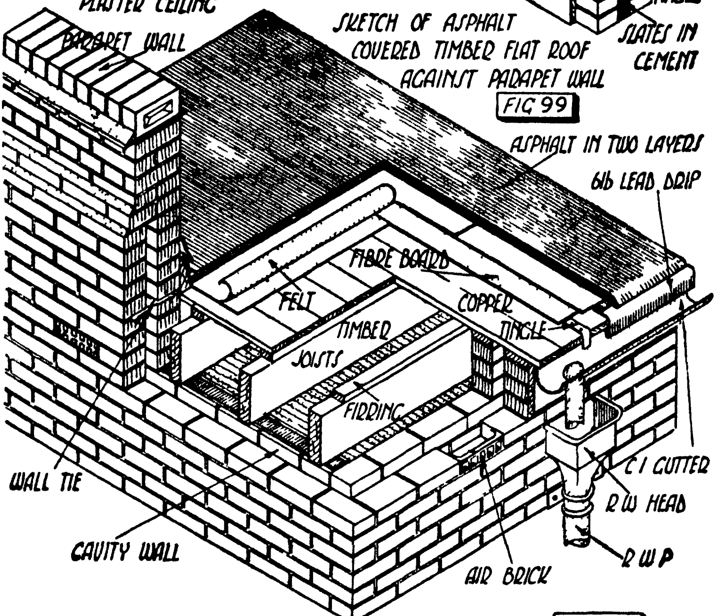
All metal roofing materials must be viewed as regards the effect of expansion and contraction on the sheets and their joints.

Because of this, the size of the sheets must be limited and should not average more than 8′ × 3′ and the sheets should be jointed by means of rolls, drips or welts as required.



SKETCH OF ASPHALT COVERED TIMBER FLAT ROOF AGAINST PARAPET WALL

FIG 99



SKETCH OF TIMBER FLAT ROOF AT VERGE FIG 100

Where metal sheets abut parapet walls, they should be finished with a cover flashing turned into the brickwork and made to cover the joint between the wall surface and the roofing materials.

Asphalt Coverings

When covering flat roofs that are constructed with timber, the asphalt should be laid in two plies, each about $\frac{3}{8}''$ thick, but this dimension may be increased if desired.

The asphalt should be laid on roofing felt and insulation can be provided by placing a layer of cork or fibre-board on the roof boarding, as shown in Figs. 99 and 100. The finished surface should have a minimum fall $1\frac{1}{2}''$ to $10'$, and where the roof covering adjoins parapet walls, etc., an asphalt up-stand should be formed against the walls and over timber angle fillets placed at the junction of the structural roof and the wall, as shown in Fig. 99.

A metal cover flashing should be turned into the bed joint of the brickwork of the parapet wall and dressed over the asphalt up-stand so as to form a capping, thus allowing the asphalt to expand and contract without uncovering the joint.

Fig. 100 illustrates the finish for an asphalt covered flat roof where the roof surface continues over the top of the wall and discharges the rain-water direct into a C.I. gutter.

To obtain an effective joint between the edge of the asphalt and the C.I. gutter a strip of lead or other sheet metal is dressed over the gutter board and fastened in a rebate formed in the edge of the roof boarding.

This strip of sheet metal is held in position by metal tingles, or tacks, which are nailed to the roof boarding, and the outside edge of the metal strip is turned up to clip the metal tingle, as shown in the sketch.

Bitumastic Coverings

There are several bitumastic coverings for flat roofs, each of which are exceptionally good if they are properly laid on an efficient foundation.

They consist chiefly of layers of flexible waterproof sheeting combined with bitumen, or of sheets comprising a fibrous base that has been thoroughly saturated and coated with ruberoid compound.

They may be laid on timber roofs as well as concrete roofs.

CHAPTER XIV

STEEL ROOF TRUSSES

A FRAMED structure comprises a number of straight members fastened together so that the stresses in each member are either in tension or compression.

Since a triangle is the only geometrical figure which cannot change its shape, unless the length of one or more of its sides are altered, it is necessary that roof trusses should be built up of a number of triangles and framed together.

Timber roof trusses, and a combination of timber with wrought and cast iron, were used very considerably at one time, but during recent years trusses made up of mild steel sections have taken their place.

Because of this change, it is not intended to describe and illustrate the old forms of 'King post' and 'Queen post' timber roof trusses, but a description of the more modern types of timber truss will be given in the next volume.

Types of Roof Trusses

The type of roof truss suitable for a specific purpose is determined by the length of span and the manner of loading.

There are certain loads which should be considered in computing the stresses in roof trusses, viz.:

(1) **Dead loads** consisting of the roof coverings, weight of truss, purlins, bracings and suspended loads, such as ceilings and mechanical equipment.

(2) **Wind loads** which are occasioned by the wind acting on the roof surfaces.

Steel roof trusses comprise the following chief members:

(1) Principal rafters or upper chord.
(2) Main tie or lower chord.

(3) Struts or web members.
(4) Secondary ties or web members.

The design of roof trusses does not come within the scope of this book, but it may be mentioned that the stresses in the various members may be assumed as follows:

Principal rafters, in compression.
Main ties in tension.
Struts, in compression.
Secondary ties, in tension.

Many of the older forms of steel roof trusses were built up with Tee sections, rods, angle sections and flats, but the modern method is to employ angle sections for all members of the truss.

An outline diagram of a steel roof truss with an effective span of 35′ 9″ is given in Fig. 109.

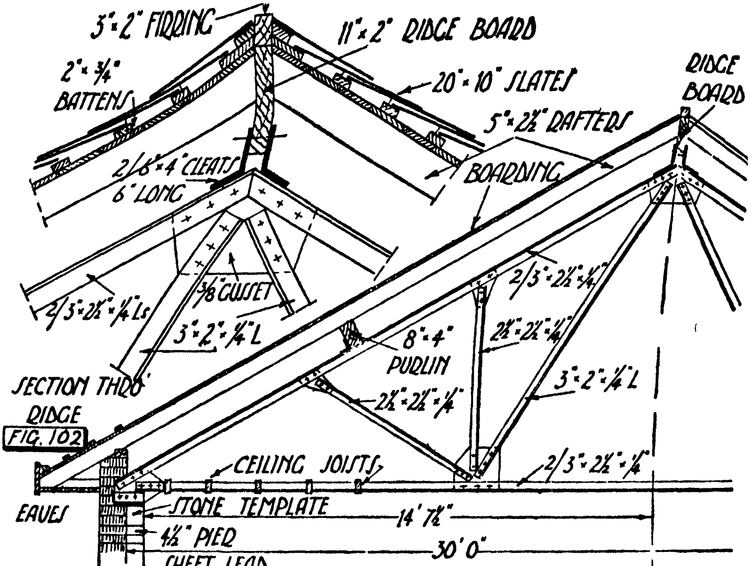
A part elevation of a steel roof truss with an effective span of 30′ is given in Fig. 101.

The members comprising the truss are all angle sections; the principal rafter and the main tie each comprise 2/3″ × 2½″ × ⅜″ L sections, placed back to back with a space between them equal to the thickness of the gusset plates, which occur at each joint.

This arrangement allows for almost perfect symmetry in the sectional area and the arrangement of the joints. The materials used for the roof covering will determine very largely the type of framework necessary for the support of the covering.

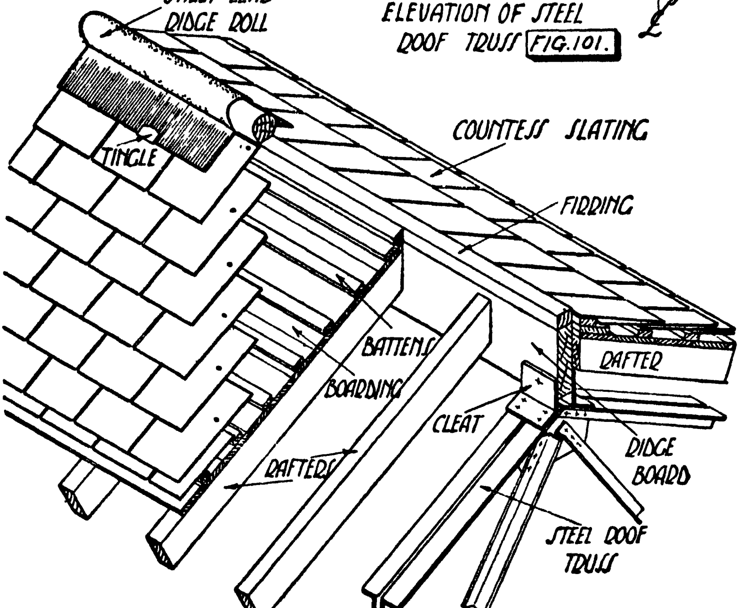
When the coverings comprise slates or tiles it is necessary to provide horizontal purlins spaced at convenient intervals up the principal rafters so that intermediate support for the common rafters is obtained. The lower end of the common rafters may be supported on a wall plate as shown in the diagram, the rafters being spaced at 16″ centres.

The main tie of this roof truss is straight between the supports and carries the ceiling joists for the support of a level ceiling, while the shoes of the truss rest upon stone templates bedded on brick piers.



SECTION THRO' RIDGE FIG. 102

ELEVATION OF STEEL ROOF TRUSS FIG. 101.



SKETCH THRO' RIDGE FIG 103.

Truss Details

The roof framework shown in Fig. 101 is of a very light character; therefore one purlin only is placed between the shoe of the truss and the ridge, and as near as possible to the joint between the strut and the principal rafter.

Details at Ridge.—The ridge board is held in position by cleats which are riveted to the principal rafters and the top of the common rafters are splay-jointed and supported against the ridge board.

A detail of the truss at the ridge is given in Fig. 102 and a sketch showing the construction and the finish for the roof covering at this part of the roof is given in Fig. 103.

Details at Eaves.—Fig. 104 is a section at the shoe of the truss and includes the details of the construction and finishings of the eaves.

A sketch showing the truss resting on a stone template and the details of the shoe, together with the construction of the eaves, is given in Fig. 105. The shoe is made up of $2/3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{3}{8}''$ Ls and $1/9'' \times 9'' \times \frac{3}{8}''$ plate and these are riveted to a $\frac{3}{8}''$ gusset-plate.

Figs. 106, 107 and 108 are detailed elevations of the joints connecting the struts and secondary ties to the main tie and principal rafter.

Roof to Assembly Hall

Fig. 109 is a line diagram of the roof truss over the Assembly Hall. The centre portion of the main tie is raised, thus allowing extra height between the floor and ceiling in the Hall.

The shoes of the truss rest upon, and are connected to steel stanchions which transmit the roof loads direct to the foundations.

Details at Eaves.—The common rafters are supported upon purlins placed over the strut and tie members and on a wall plate bedded on the 9″ external wall.

An elevation of the shoe portion of the truss and a detailed section showing the construction of the eaves is given in Fig. 110.

Details at Ridge.—A section through the ridge showing the

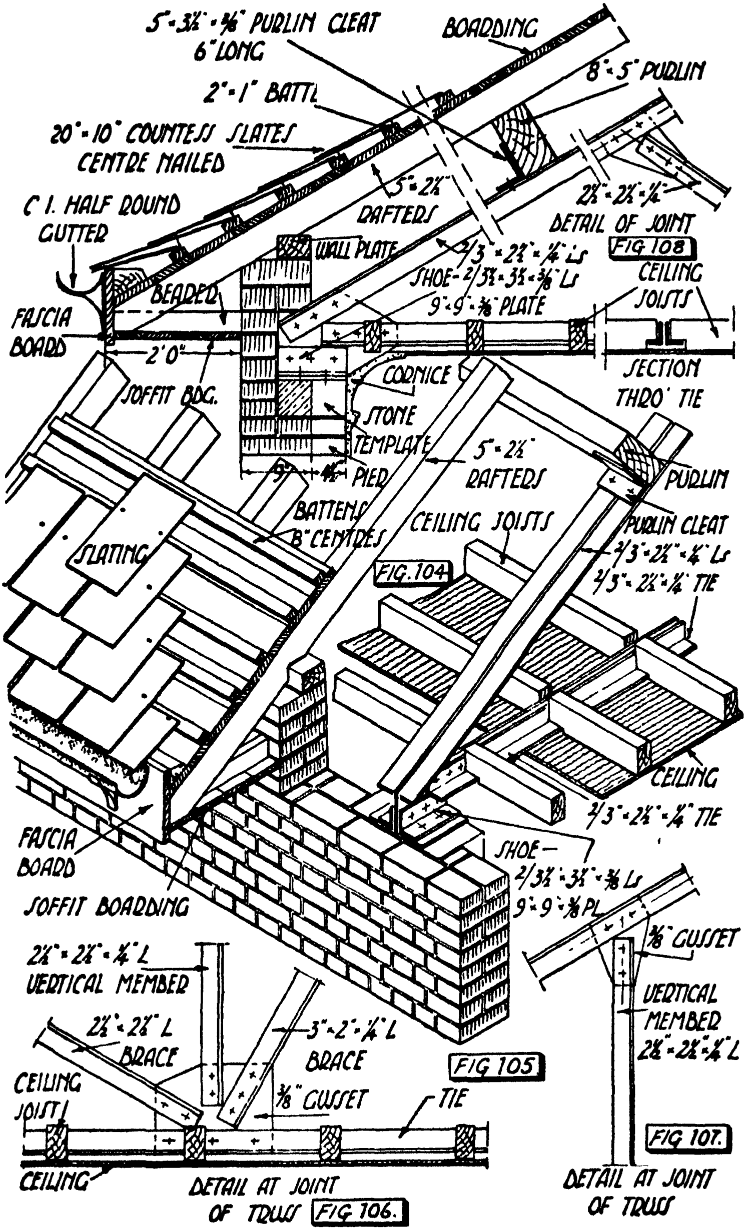


FIG. 104

FIG 105

FIG 106.

FIG 107.

FIG 108

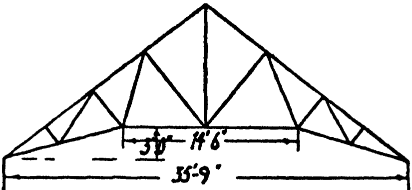
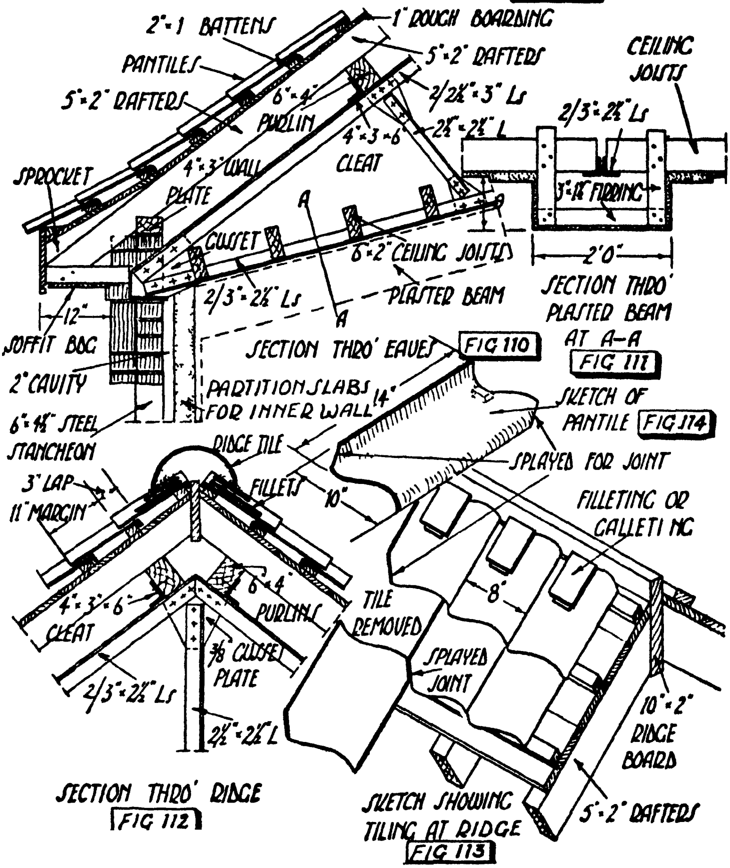


DIAGRAM OF ROOF TRUSS FIG 109



SECTION THRO' EAVES FIG 110

SECTION THRO' PLASTER BEAM AT A–A FIG 111

SECTION THRO' RIDGE FIG 112

SKETCH SHOWING TILING AT RIDGE FIG 113

top end of the common rafters supported on purlins and splay-jointed against the ridge board, which is not connected to the steel truss, is given in Fig. 112.

Parallel Gutters

When a parapet gutter is desired at the foot of a pitched roof supported on steel roof trusses, a slight modification is necessary in the construction of the roof framework.

The gutter may be tapered from the crown of the gutter to the outlets (a tapered gutter is illustrated in Vol. I), or the gutter may be formed parallel, in which case the sides of the gutter remain parallel throughout its length, but the depth increases towards the outlets. In the example given in Figs. 115 and 116 the cross-bearers are supported on a fillet piece nailed to the side of the lowest purlin and on a bearer placed against the wall. This bearer receives intermediate support from metal corbels built in the wall, as shown in the sketch Fig. 116.

The roof boarding is laid direct on the purlins instead of being supported on common rafters as shown in the previous examples.

The sheet lead is dressed over the gutter boarding and finishes on a board behind the tilting fillet.

Very little roof framework is required for the support of corrugated iron and asbestos roofing sheets as these are light and do not require intermediate support at frequent intervals.

Roofing Tiles

In work of a cheap character roofing tiles are laid on battens which are nailed direct to the top surfaces of the rafters without any additional protection against the weather, or they may be 'torched' with mortar on their underside to prevent draughts and the incursion of rain.

A better method is to close-board the roof surface or cover the rafters with roofing felt and then nail the battens to the required gauge.

If the roof is close-boarded and covered with felt it may be

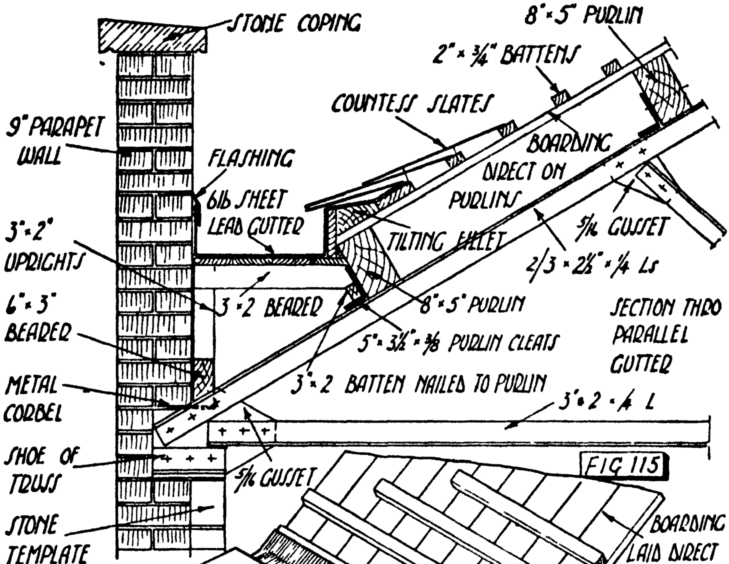
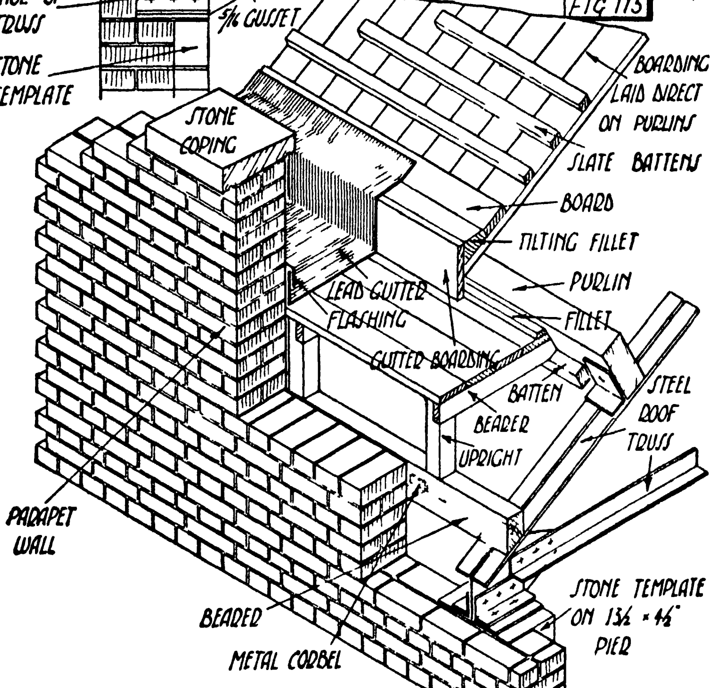


FIG 115



SKETCH SHOWING CONSTRUCTION OF PARALLEL GUTTER FIG 116

advisable to nail counter battens in a sloping position up the roof surface before fixing the horizontal battens.

Pan-tiling

These tiles are about 14" × 9" and curved as shown in Figs. 113 and 114.

They are laid on roof surfaces with one thickness of tiles instead of two between the horizontal laps, thereby resulting in a lighter system of tiling.

Pan-tiles are hung on the battens by projecting nibs formed on the under surface of the tiles, which are lapped vertically as well as horizontally as shown in Fig. 113.

Pan-tiles are more suitable for plain roof surfaces, as by their use difficulties occur in the formation of valleys, hips and verges.

Ridges are best finished with half-round ridge tiles, and the spaces between the ridge tiles and the hollow portion of the pan-tiles are filled with pieces of plain tiles bedded in cement mortar, termed filleting or galleting, as shown in Fig. 113.

Sections showing the tiling at an eaves and ridge are given in Figs. 110 and 112.

CHAPTER XV

PLASTERWORK

Firring

THE term ' firring ' is used to include any framework of wood or metal not part of the structure and is employed to even, or build up, surfaces to achieve the requirements of architectural design.

Wood firring consists of a light framing of wood studs built up wherever required in the interior of buildings so that plastered surfaces may be aligned, and to assist in covering floor-beams, ventilation ducts, coved ceilings and cornices.

The firring for the covering of a R.S. beam is shown in Fig. 68. It is only necessary, in cases such as this, to frame up timber studs and battens in a manner that will form a fixing for the laths and plaster and to prevent any tendency of subsequent cracks and settlement.

The firring pieces may be covered with wood laths as a backing for the plasterwork, or they may be covered with expanded metal sheets or metal lathing.

The firring requisite for the forming of a plaster ceiling and beam covering over a bay window may be seen in Fig. 157.

Firring pieces are used also in the construction of timber flat roofs to obtain the necessary ' fall ' for the roof surface. It is usual to nail tapered pieces of timber on the top surfaces of the joists, but pieces of graduated thickness can be used if the joists run at right angles to the ' fall ' of the roof surfaces as shown in Figs. 99 and 100. False beams are often formed as projections to ceilings and these are usually framed out in timber as a backing for fibrous plaster slabs and mouldings. Fig. 117 is a section through one of the plaster beams over the Assembly Hall and shows the arrangement of the timber firring for the support of the fibrous plasterwork.

A sketch showing the position of the ceiling joists, and the method of supporting them on the main tie beam of the steel roof-truss, is given in Fig. 118. The firring for the plasterwork of the Proscenium arch of the Assembly Hall is illustrated in Figs. 121 and 122, and includes the timber framing for the plaster architrave and cornice.

Solid plasterwork is the term used to differentiate between this class of work and that which is known as fibrous plasterwork.

Fibrous plasterwork is a combination of plaster of Paris and canvas and laths, united into a structural mass in the form of precast slabs and lengths of mouldings, which are prepared ready for fixing in position.

Among the advantages of fibrous plaster are speed of erection and lightness of weight, and it is extensively used for ornamental and elaborately moulded work, beam coverings, suspended ceilings, covings and cornices. When fibrous fibre is used as the covering for floor beams, a certain amount of firring or bracketing out from the structural members is necessary.

Details of Plasterwork

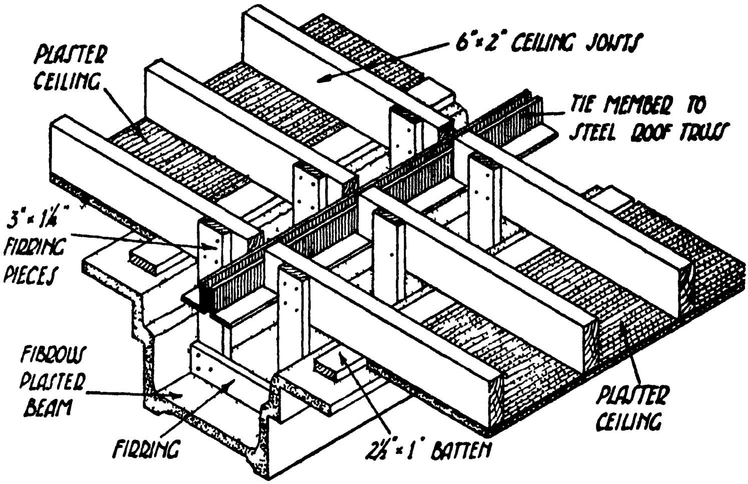
Details of the fibrous plaster arch and roof beam over the Proscenium arch of the Assembly Hall, including a sketch showing the arrangement of the beam casings and the arrangement of the firring for the support of the plasterwork, are given in Figs. 121 and 122.

Fibrous plaster may be secured to the wood firring pieces with galvanised iron nails and screws but galvanised wire may be fixed in the casts and used as a means for attachment.

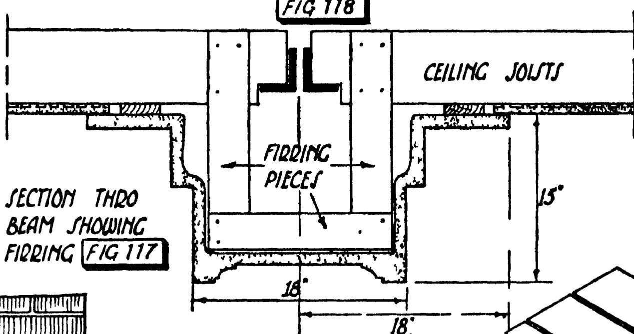
In certain types of work, and where the use of wood firring is undesirable, metal lathing and rods are framed together and attached to the structure and form the grounds for the support of the fibrous plaster sheet, covings and mouldings.

A section and sketch showing the firring and fibrous plaster for one of the beams and the ceiling over the Assembly Hall are given in Figs. 117 and 118.

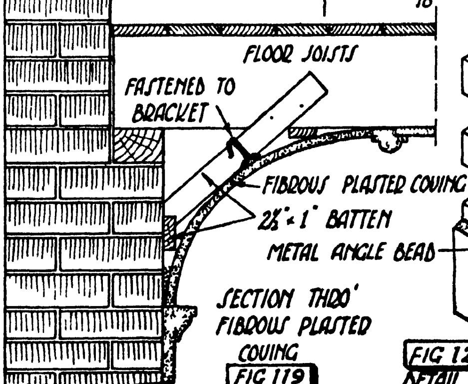
A section through a fibrous plaster coving supported on



SKETCH OF FIBROUS PLASTER BEAM
FIG 118



SECTION THRO BEAM SHOWING FIRRING FIG 117



SECTION THRO' FIBROUS PLASTER COVING
FIG 119

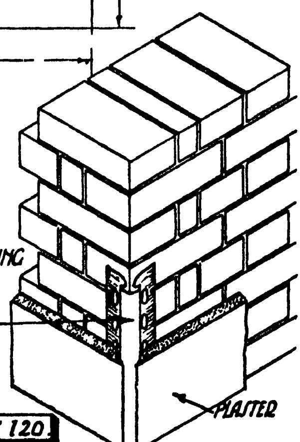
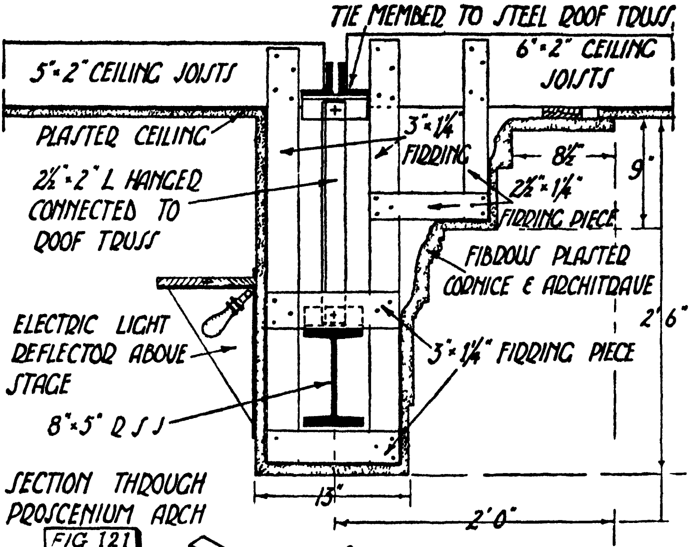
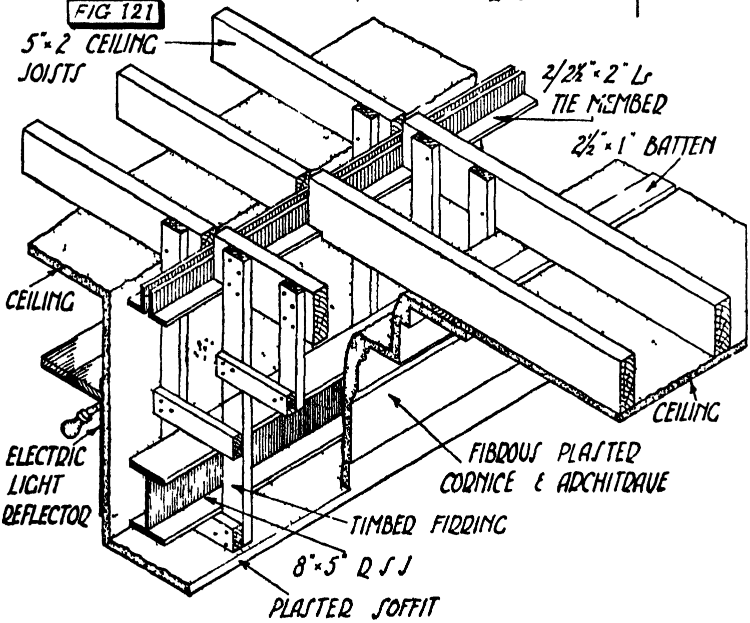


FIG 120
DETAIL OF METAL ANGLE BEAD



SECTION THROUGH PROSCENIUM ARCH FIG 121



SKETCH of FIBROUS PLASTER ARCH FIG 122

brackets or angle pieces fixed across the angle between the floor joists and the wall surfaces is given in Fig. 119.

External angles in plasterwork are formed in various ways. Sometimes a wood angle bead is fixed vertically along the intersection of the two wall surfaces, but this method is not to be recommended. A better result will be obtained by forming the angle with one of the hard setting plasters such as Keene's cement on a Portland cement backing.

The sharp angle of intersection should be rounded off, more or less, according to the finish required.

Metal angle beads are now being used very considerably for reinforcing plastered corners.

The metal beads are easily fixed to the brickwork and are made in about 10′ lengths from No. 22 gauge galvanised steel sheets.

A sketch detail showing the fixing of a metal angle bead is given in Fig. 120.

CHAPTER XVI

PARTITION WALLS

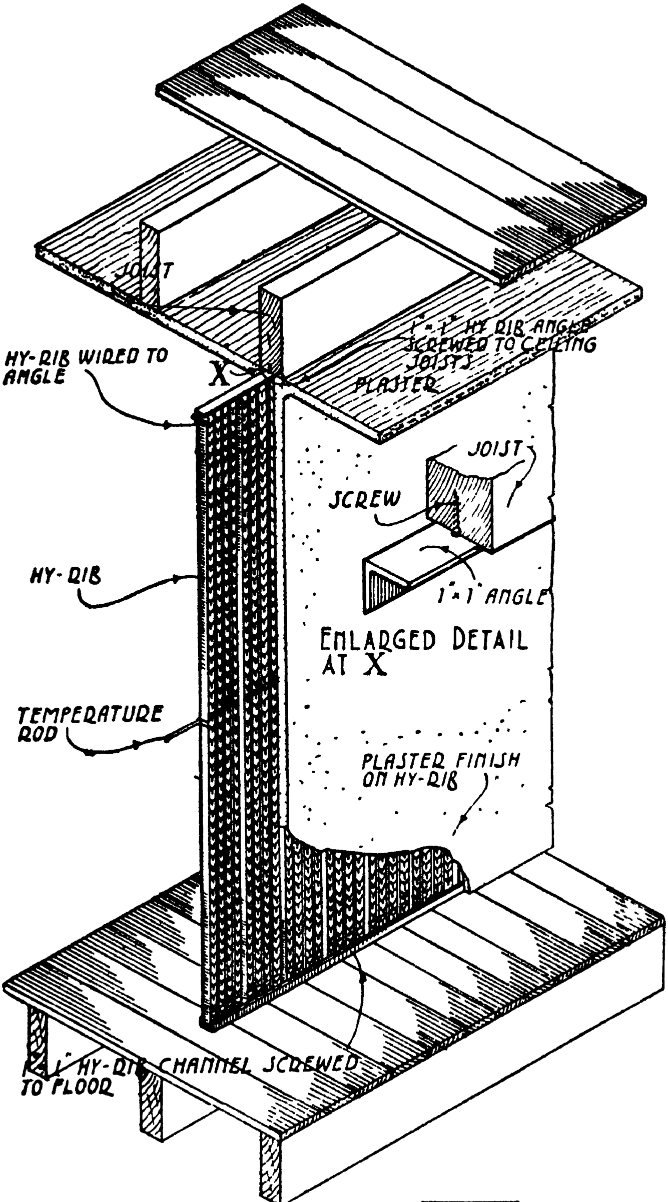
WOOD-stud and framed partitions are being superseded in many instances by various forms of block, slab and steel-mesh partitions, but the wood-stud partition has many points in its favour if the construction is carried out in a manner that will enable it to fulfil its proper function, particularly in regard to sound insulation. The traditional method of constructing wood-stud partition walls was to cover the studs with wood laths and then apply two or three coatings of lime plaster to form the finished surfaces, but this method is not conducive to the best results.

Fibre-boards are now being used in preference to laths for covering the timber framework. The sheets are nailed to the timber studs and then covered with one or two coats of plaster, or the joints between the boards are covered with battens and the finished surface produced by placing the decoration direct on the surface of the wall board, as shown in Figs. 127 and 128.

Plaster boards are becoming popular as a rapid and economical base for the plasterwork of partition walls and ceilings.

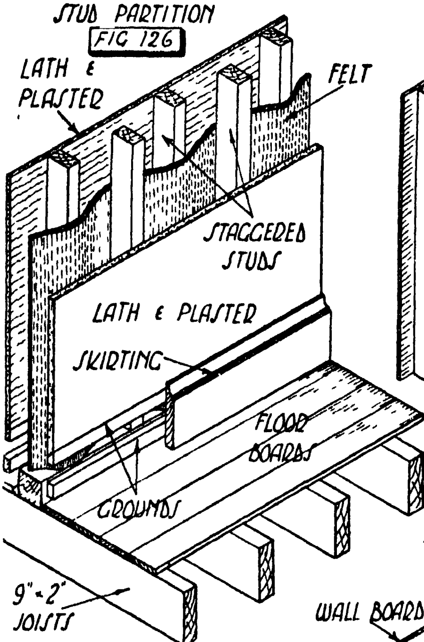
The boards should be nailed along their four edges and where the studs occur in the centre of the boards. These should be butt-jointed with an open joint, from $\frac{1}{4}''$ to $\frac{3}{8}''$ wide between the boards, so that plaster may be inserted in the gap between the boards and the joints covered with bandage scrim.

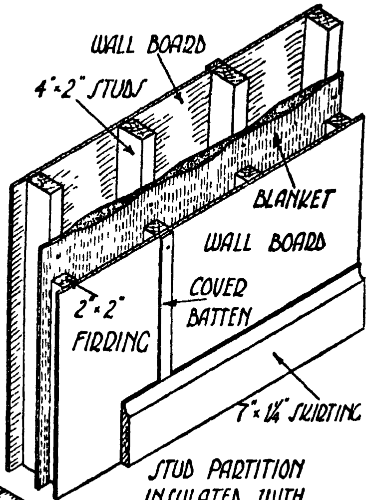
When the jointing mixture has set, the whole of the surface area may be covered with a thin coat of hemi-hydrate lime and sand, or hard wall plaster, such as 'Sirapite' or 'Thistle' plaster.



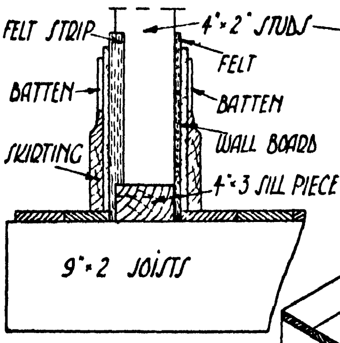
METAL CORE PARTITION FIG. 123.

SKETCH OF STAGGERED STUD PARTITION
FIG 126

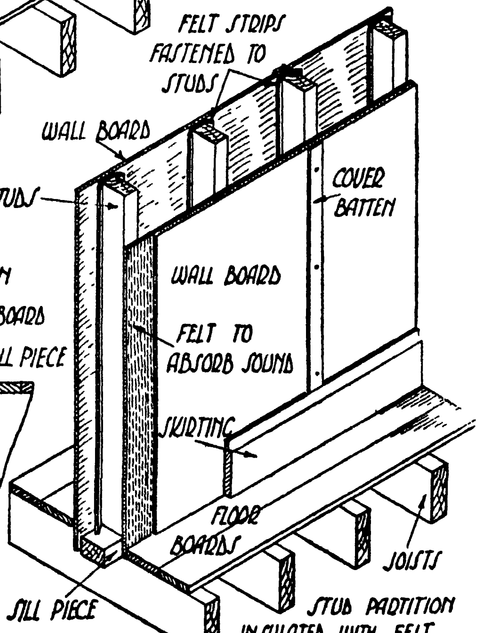




STUD PARTITION INSULATED WITH BLANKET
FIG. 127



DETAIL SECTION THRO SILL PIECE
FIG 129



STUD PARTITION INSULATED WITH FELT
FIG. 128

Wall Insulation

The insulating value of a partition wall will depend chiefly upon the coverings used and method adopted in its construction.

A wood-stud partition wall will have fairly good insulative qualities if the studs are placed staggered, so that actually two partitions are formed back to back, and a layer of felt or other insulating material inserted between the studs, as shown in Fig. 126.

Fig. 128 illustrates the construction of a single stud partition, insulated by fastening strips of felt or sound absorbing materials to the surfaces of the studs and then applying sheets of wood fibre or plaster board.

An alternative suggestion is included in the sketch, which shows a felt blanket introduced between the faces of the studs and the fibre sheets. If preferred both methods may be incorporated in the same partition with very good results. A section through the base of the partition wall is given in Fig. 129.

Another method of insulating a wood-stud partition wall, but one that increases the thickness of the wall, may be seen in the sketch Fig. 127.

A felt blanket is fastened to the face of the studs and vertical firring pieces are placed over the blanket and nailed to the studs to form a base for fixing the wall boards.

Cork-board sheets are often used as an insulating material in partition walls, and when these are to form part of the construction of a wood-stud partition the sheets are fastened to the faces of the studs in a manner similar to the felt blanket, shown in Fig. 128. The insulation properties of cork-board are derived from the prisoned air particles in its cellular structure.

Although the plaster coatings may be applied direct to the cork-board surfaces it is preferable to cover the boards with wire netting or expanded metal so as to form an effective key.

CHAPTER XVII

DOORS

DOORS are named in accordance with the position they are to occupy, their style, the arrangements of their several parts and the method by which they are hung.

Internal doors are those which are situated inside a building and lead from one compartment to another. Their style is determined by the character of the surrounding decorations and their fitting is dependent upon the construction and dimensions of the structural or enclosing wall, in which the door is to be situated. Details illustrating the construction and finishings for an internal door are given in Figs. 138—143. The door is a flush type, comprising plywood surfaces secured to a laminated core and situated in a 4½" partition wall. It is surrounded with solid rebated linings fixed to the edges of the rough grounds, which are covered with a built-up architrave.

A sectional sketch through the jamb of the doorway showing in detail the arrangement for the fixing of the linings, grounds and architrave, is given in Fig. 140.

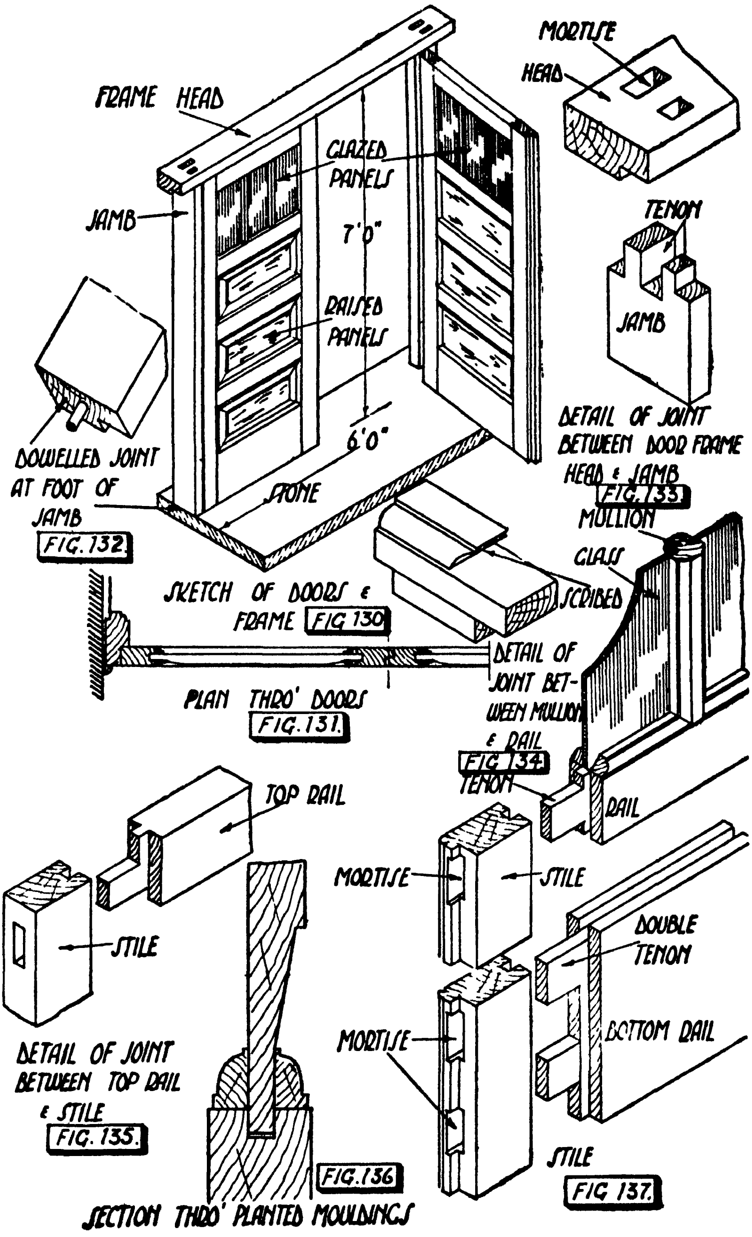
The linings are secured to the edges of the grounds without the framing which is necessary when built-up linings and casings are used. A section through the jamb is given in Fig. 139. Fig. 141 is a section through the head of the doorway and includes the details of the metal frame for the fixed fanlights also the transom and head linings.

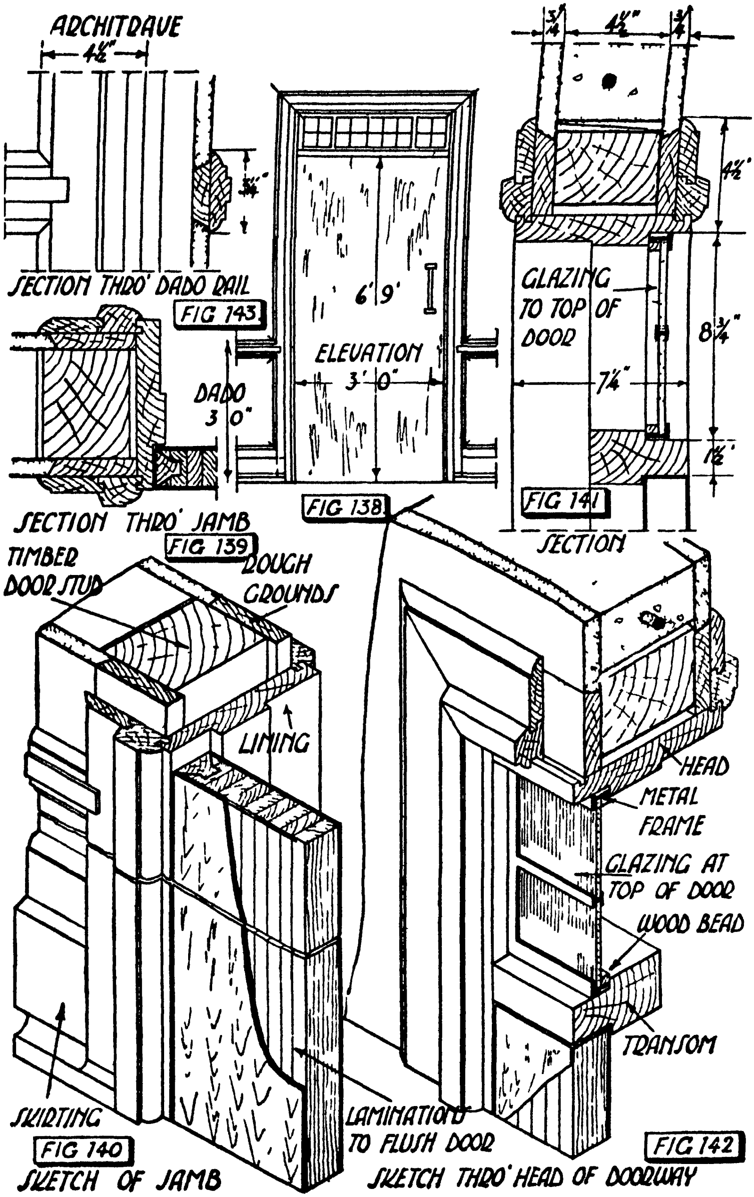
These details are further illustrated in the sketch Fig. 142.

An elevation of the scribed mitre joint between the dado rail and the architrave and a section through the dado rail are given in Fig. 143.

External doors are those that are situated in openings in external walls and may be termed Entrance Doors.

Wide entrance doors are frequently hung in two leaves,


FRAME HEAD
GLAZED PANELS
JAMB
7'0"
RAISED PANELS
6'0"
STONE
DOWELLED JOINT AT FOOT OF JAMB
FIG. 132.
SKETCH OF DOORS & FRAME FIG 130
PLAN THRO' DOORS
FIG. 131.
MORTISE
HEAD
TENON
JAMB
DETAIL OF JOINT BETWEEN DOOR FRAME HEAD & JAMB
FIG. 133
MULLION
GLASS
SCRIBED
DETAIL OF JOINT BETWEEN MULLION & RAIL
FIG 134
TENON
RAIL
TOP RAIL
STILE
DETAIL OF JOINT BETWEEN TOP RAIL & STILE
FIG. 135.
FIG. 136
SECTION THRO' PLANTED MOULDINGS
MORTISE
STILE
MORTISE
DOUBLE TENON
BOTTOM RAIL
STILE
FIG 137.


ARCHITRAVE
4½"
3¼"
SECTION THRO' DADO RAIL
FIG 143
SECTION THRO' JAMB
FIG 139
DADO
3' 0"
6' 9"
ELEVATION
3' 0"
FIG 138
¾
4½"
¾
4½"
GLAZING TO TOP OF DOOR
8¾"
7¼"
1½"
FIG 141
SECTION
TIMBER DOOR STUD
ROUGH GROUNDS
LINING
SKIRTING
FIG 140
SKETCH OF JAMB
LAMINATION TO FLUSH DOOR
HEAD
METAL FRAME
GLAZING AT TOP OF DOOR
WOOD BEAD
TRANSOM
FIG 142
SKETCH THRO' HEAD OF DOORWAY

rebated together in the middle, and termed double-hung doors, each leaf of which comprises two pieces of framing, complete with two stiles and rails.

Framed and panelled doors are invariably preferred for Entrance Doors and are usually made in hard-wood and hung in solid rebated frames.

An elevation plan and section of the double-hung door which forms part of the Entrance Doorway to the Assembly Hall are given in Figs. 52–55.

The sketch Fig. 56 illustrates the construction of the brick-work of the Entrance feature which surrounds the doorway and includes the joinery comprising the door and fittings.

Each door-leaf is framed-up with three panels and a top glazed panel.

A sketch of the complete door fitted in its solid rebated frame and details of the various joint connections are given in Figs. 130–137.

Door Linings

External doors are invariably hung in solid rebated frames in a manner similar to casement windows. The head of the frame should project beyond the posts for building into the surrounding brickwork and the feet of the posts secured to the threshold by means of dowelled joints. A detail of this joint is given in Fig. 132.

Internal doors are often hung to built-up linings and these vary in construction according to the thickness of the wall in which the opening is situated, and the character of the finished details.

Plain lining is the term applied to a lining comprising one flat board fixed at the edges to the rough grounds and when the lining is rebated on both edges it is termed a double rebate lining, as shown in Figs. 139–142.

For openings in walls 9″ thick or more, it is preferable to frame-up the grounds and cover the framing with a casing, as shown in Figs. 147 and 148. In this example the casing is double rebated and comprises two boards joined together in the centre with a ploughed and tongued joint.

Figs. 144 and 145 are details of built-up casings fixed to specially formed grounds.

Door Architraves

The moulding surrounding a doorway is termed an architrave, and is intended to cover the joint between the grounds and the plaster.

Architraves may rest upon a plinth block, and be complete in section in one board of sufficient width to cover the joints between the grounds and casings as shown in Figs. 144–147.

In some instances a built-up architrave is necessary or preferred, the width of the moulding is then obtained by jointing two or more boards which may be grooved and tongued to the side and head linings as shown in Figs. 140–142.

Flush Doors

The introduction of the uses of veneers and plywoods has revolutionised the technique of joinery.

Frame and panel construction was the method invariably adopted for doors, the members of the framing being mortised and tenoned, or dowelled together, but by the introduction of plywoods a change in construction has taken place and the constructional frame of the door is completely concealed by a flush face of veneer or plywood.

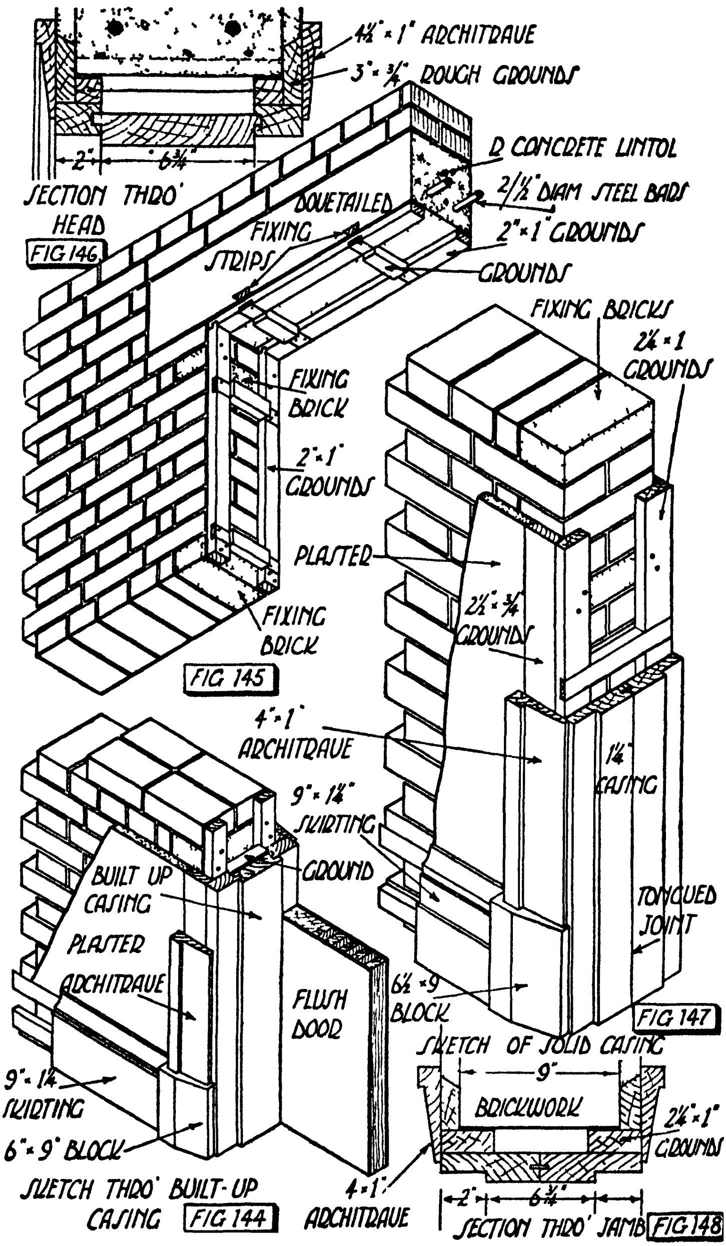
Certain structural requirements are necessary if flush doors are to give satisfaction in use.

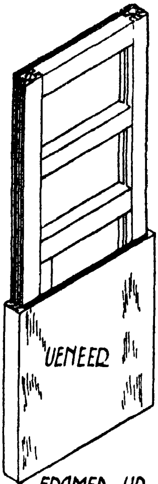
There should be no tendency to twisting, and strength must be combined with lightness.

Door technique has developed from the battened and braced door to the framed and panelled door and the modern flush door. Panel construction is still the vogue for external and entrance doors.

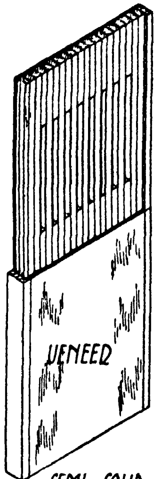
Flush doors may be made from sheets of plywood, but this type of door is only suited to small doors, as the material is likely to twist.

One of the most popular types of flush door and one that resists the tendency to twist comprises a laminated or blockboard core formed of narrow strips of wood running the length


4½" × 1" ARCHITRAVE
3" × ¾" ROUGH GROUNDS
2"
6¾"
SECTION THRO' HEAD
FIG 146
R CONCRETE LINTOL
2/½" DIAM STEEL BARS
DOVETAILED FIXING STRIPS
2" × 1" GROUNDS
GROUNDS
FIXING BRICKS
2¼ × 1 GROUNDS
FIXING BRICK
2" × 1" GROUNDS
PLASTER
2½" × ¾" GROUNDS
FIXING BRICK
FIG 145
4" × 1" ARCHITRAVE
1¼" CASING
9" × 1¼" SKIRTING
GROUND
BUILT UP CASING
PLASTER
ARCHITRAVE
FLUSH DOOR
TONGUED JOINT
6½ × 9 BLOCK
FIG 147
SKETCH OF SOLID CASING
9"
BRICKWORK
2¼" × 1" GROUNDS
9" × 1¼ SKIRTING
6" × 9" BLOCK
4 × 1" ARCHITRAVE
2"
6¾"
SKETCH THRO' BUILT-UP CASING
FIG 144
SECTION THRO' JAMB
FIG 148

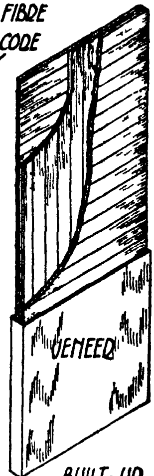


FRAMED UP CORE
FIG 149

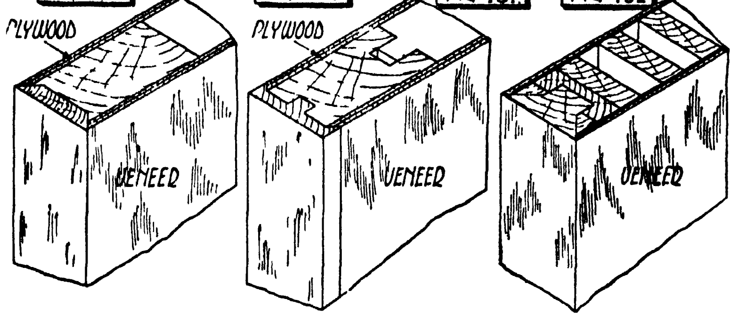


SEMI-SOLID CONSTRUCTION
FIG 150

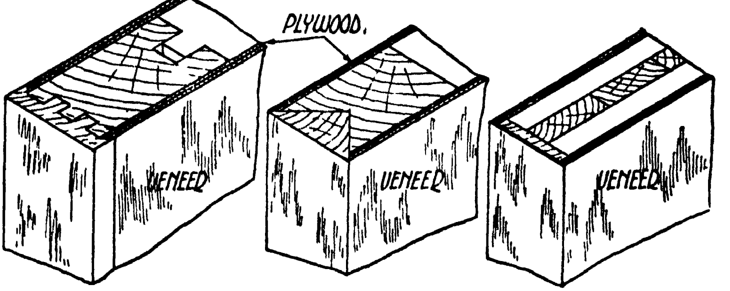
FRAMED & FIBRE CORE
FIG 151.



BUILT-UP CORE
FIG 152



METHODS OF FINISHING THE EDGES OF FLUSH DOORS
FIG 153



of the door and glued together, and faced on each side with sheets of plywood.

Fig. 149 is a sketch of a framed-up core which is covered with plywood and veneer.

Fig. 150 is a sketch of a door of the laminated core type, the strips being spaced apart in the centre of the door to allow for a certain amount of air circulation.

Fig. 151 shows a framed and fibre-core door, the space between the framing members being filled with fibre packing which is tightly pressed in position.

Fig. 152 shows a core built-up of several layers of board, the centre one being laid length-ways and the two outer layers crossways and covered with plywood or veneer.

The laminations and plies of flush doors are bonded together with synthetic resin, and when flush doors are required with specially figured woods, veneers may be applied over the plywood. To prevent the edges of the sheets being exposed on the vertical edges of the doors, and also to give strength and finish to the edges, vertical finishings strips are tongued and grooved, or simply glued to the edges of the doors, as shown in the details given in Fig. 153.

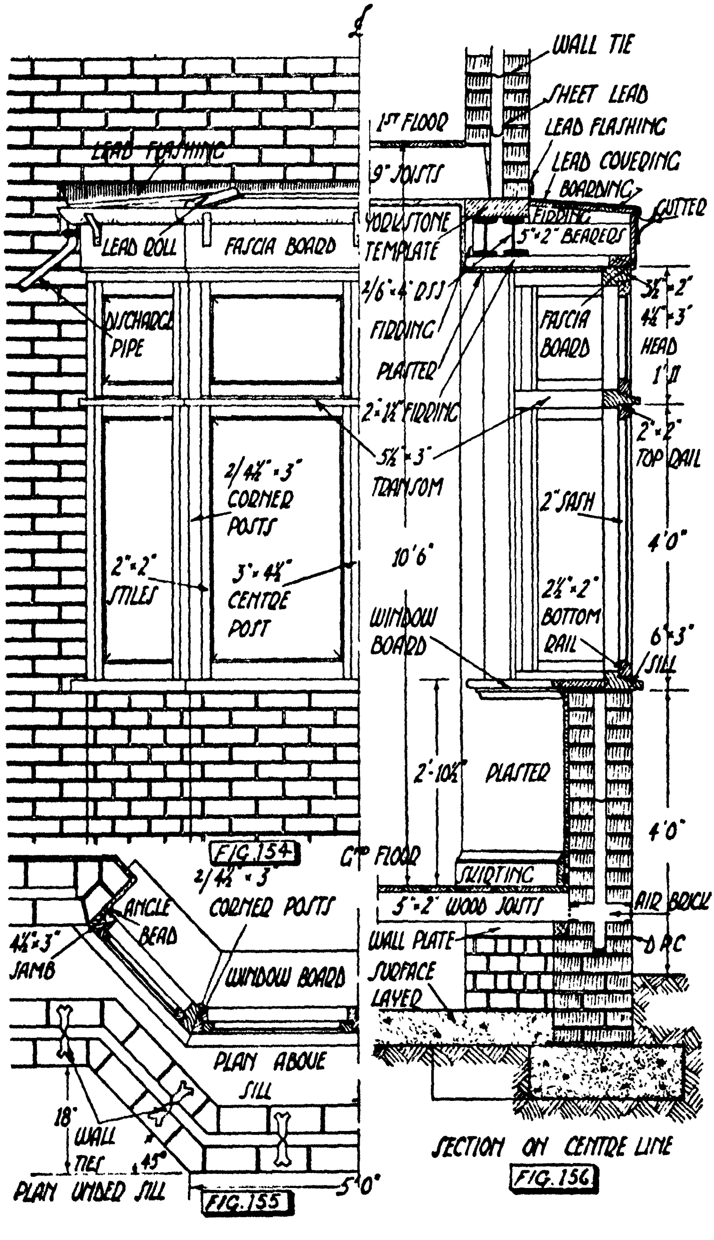


FIG. 154

FIG. 155

FIG. 156

CHAPTER XVIII

BAY WINDOW CONSTRUCTION

BAY windows, either square or polygonal in plan, are usual features in domestic buildings. The construction of a polygonal bay window projecting from a cavity wall is illustrated in Figs. 154–156.

Window-frames and Sashes

The window-frames and sashes are of the casement type and differ very little in detail from those shown in Vol. I.

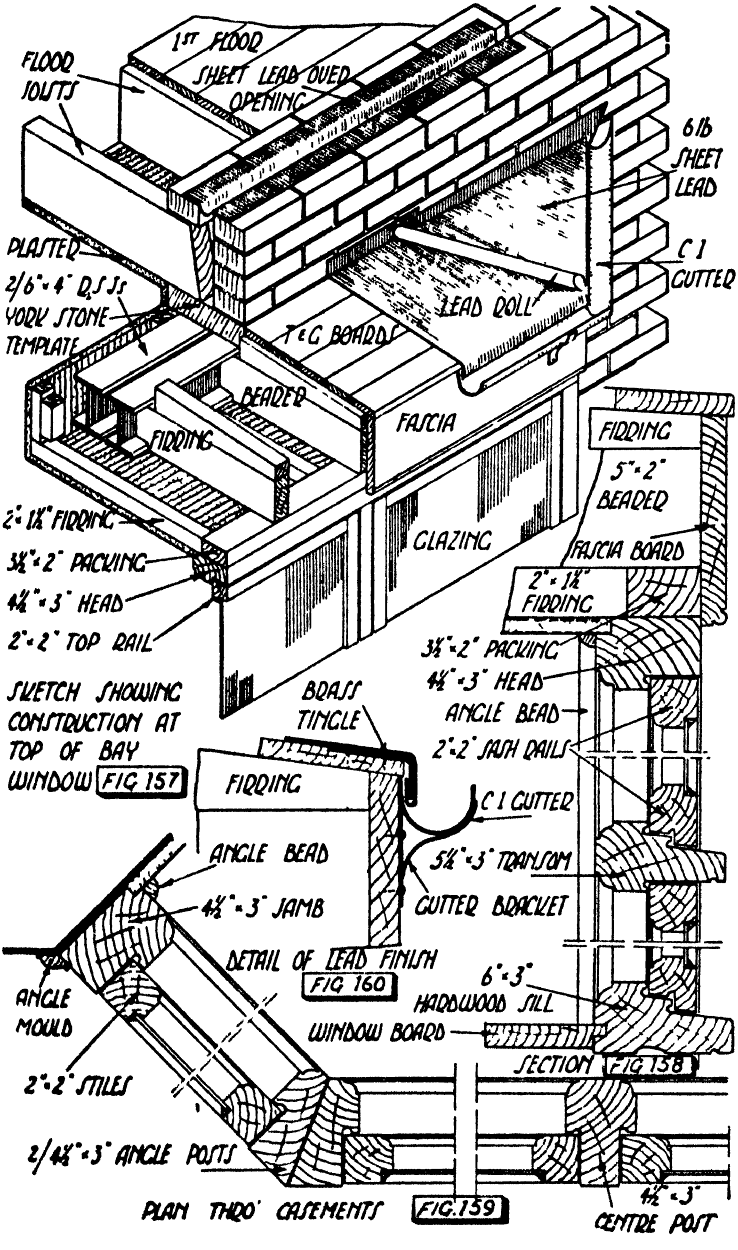
But in this example, the window-frame is intended to form part of the structural work and not merely as a fitting in an opening.

The hard-wood sill is bedded direct on the brick cavity wall and the roof bearers are supported on the head of the frame, while 2/6″ × 4″ R.S.J.s span the opening and carry the main wall above.

The windows consist of 6″ × 3″ sill, 4½″ × 3″ jambs, 2/4½″ × 3″ corner posts, 4½″ × 3″ centre posts, 4½″ × 3″ head, 5½″ × 3″ transom and 2″ sashes to open outwards. Detailed vertical and horizontal sections through the window, showing the construction of the frames and sashes and the details at the top portion of the bay window, including the finishings for the roof, are given in Figs. 158–160. A sketch showing the construction of the roof over the window is given in Fig. 157.

Metal Frames and Sashes

Window-frames and sashes are now in general use for all types of buildings, the chief advantage of the use of metal as a window fitting being that it allows for a larger glazing area and therefore permits the maximum amount of light to enter the room.



SKETCH SHOWING CONSTRUCTION AT TOP OF BAY WINDOW FIG 157

SECTION FIG 158

PLAN THRO' CASEMENTS FIG 159

DETAIL OF LEAD FINISH FIG 160

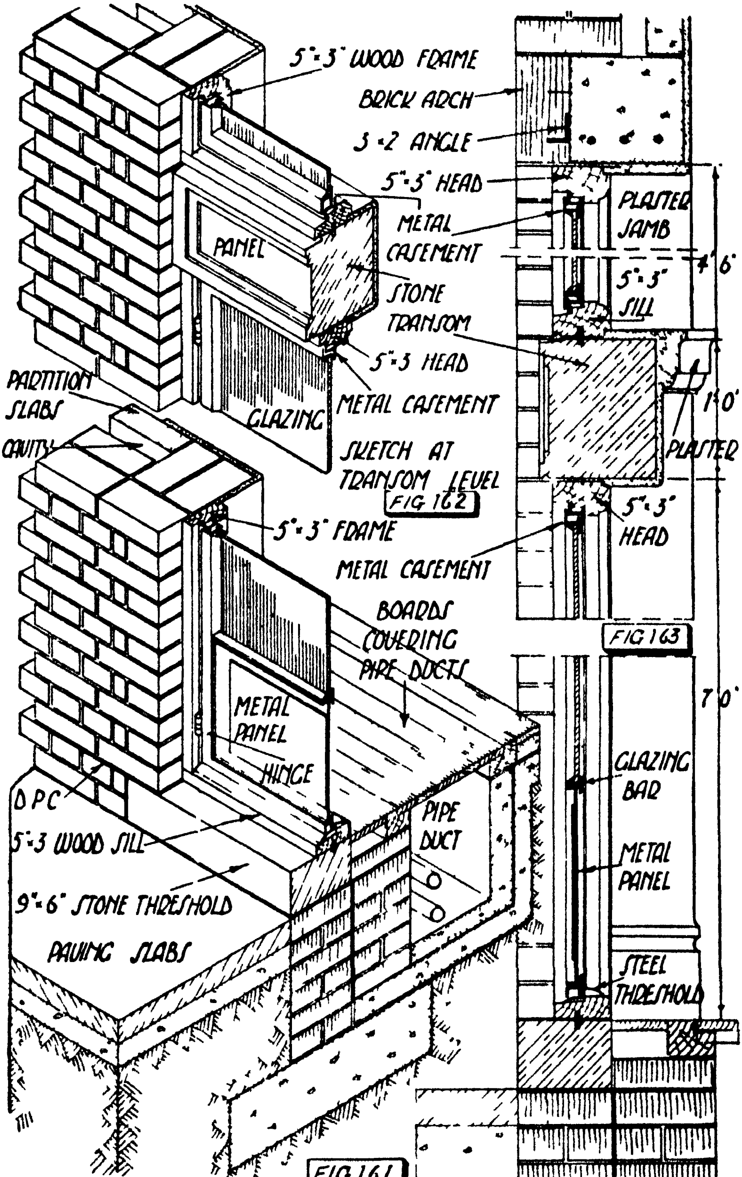


FIG 161
SKETCH SHOWING BOTTOM PORTION OF WINDOW

SECTION THROUGH CASEMENT WINDOWS FIG 164.

Metal frames and sashes should be painted frequently, especially when they are situated in salt-laden atmospheres as they are liable to become affected by corrosion.

Details of a metal window-frame and sash, fitted in an opening in a cavity wall, are given in Figs. 35, 36 and 37.

To meet the requirements of the design of some buildings, metal casements, including the frame and sashes, are fixed in solid wood frames, which in turn are fitted in the window opening in the same manner as when wood sashes are used.

Details showing a metal casement, fitted into a wood frame and forming part of the construction of one of the window openings of the Assembly Hall, are given in Figs. 161–164.

The window opening is situated in a cavity wall and the lower light of the window comprises two sashes which open out to give access to, or egress from, the Hall.

The top light is separated from the lower light by a stone transom which acts as a sill for the top light and a head over the lower light; a sketch detail of the transom is shown in Fig. 162, the plaster moulding being omitted as an alternative finish.

Fig. 161 shows the construction at the base of the lower window and includes the provision of a pipe-duct in the floor of the Assembly Hall.

Detailed sections through the lower and upper lights are given in Figs. 163 and 164.

CHAPTER XIX

STAIRS

STAIRS are provided to give access to, and descent from, the various floors comprised in a building, and they should be designed so that they may be ascended or descended with ease.

It is of the utmost importance that the stairway in a fire-resisting building is constructed with incombustible materials, such as concrete, steel and, in some instances, natural stone.

Stairs should be wide enough to enable traffic to proceed up and down simultaneously, and there should be a proper ratio of tread to rise, and resting places or landings provided in the height between floor and floor.

Terms

The following are the principal terms used in connection with stairs :—

Staircase is the apartment in which the stairs are situated.

Flight is a series of steps between landings.

Step is the unit in a flight of stairs and often termed a flier.

Tread is the horizontal upper portion of a step.

Riser is the vertical or front portion of a step.

Landing is the horizontal platform at the top of a flight of steps.

Rise is the vertical distance between two successive treads.

Going is the horizontal distance between two risers.

Winder is a step used for changing the direction of a flight of steps.

Pitch is the angle of inclination between a line joining the nosings of each step in a flight and the floor.

Headroom is the vertical distance between the nosings of one flight of steps and the soffit of the flight of steps immediately above.

Stairs in domestic buildings of moderate size and those having timber-joisted floors are generally constructed of timber because they are light and do not require such strong supports as those constructed with incombustible materials.

Types of Stair

Straight stair (Figs. 168, 169) is one in which all the steps lead in the same direction. This type of stair may consist of one or more flights of steps.

Dog-legged stair (Fig. 165) is one in which each successive flight of steps rises in an opposite direction, the outer end of the steps in each flight being vertically over those in the flight immediately above or below.

Open newel stair (Fig. 166) is a stair in which a rectangular well-hole is formed in the centre and continues from the bottom to the top of a staircase.

A similar stair may include a series of winders instead of quarter-space landings. Such a stair may be termed a geometrical stair, providing the change in the direction of the steps is obtained without occasioning a break in the continuity of the handrail from floor to floor.

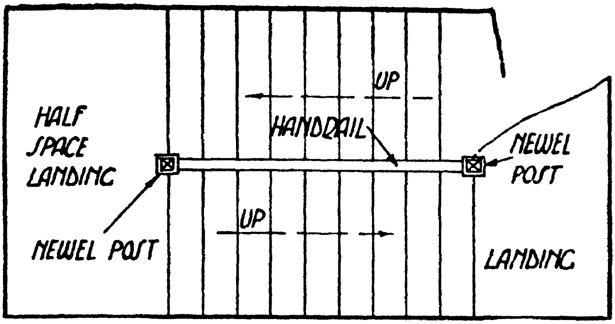
A plan of an open newel stair with winder steps is given in Fig. 167.

Wood Stairs.—The steps in wood stairs are framed casings comprising boards which are termed treads and risers. The treads are usually obtained from thicker boards than the risers and are united to the risers by grooved, tongued and grooved, or butt joints. A detail plan and section of a flight of wood steps rising from the Assembly Hall floor to the stage floor are given in Figs. 168 and 169.

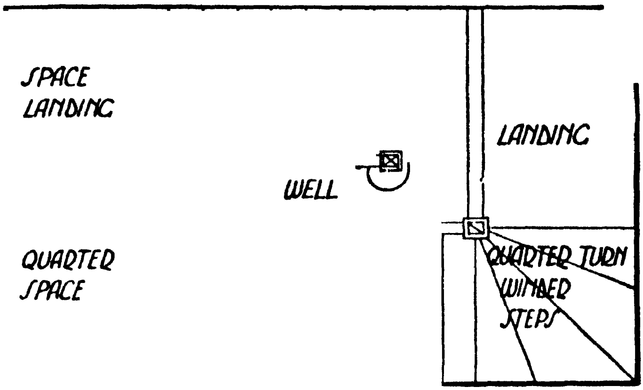
Wood stairs may comprise :—

STRINGS.—These are inclined supports at each end of the steps and may be either 'closed' or 'housed,' the treads and risers being housed into the strings for support, as shown in Figs. 170 and 172.

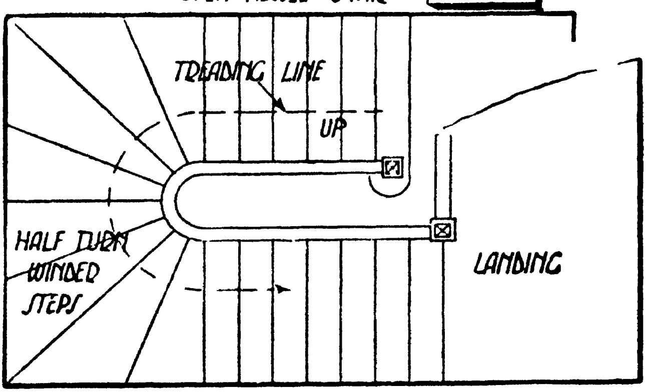
CUT STRINGS are the supports at each end of the steps, their upper edges being notched to accommodate the treads and risers.



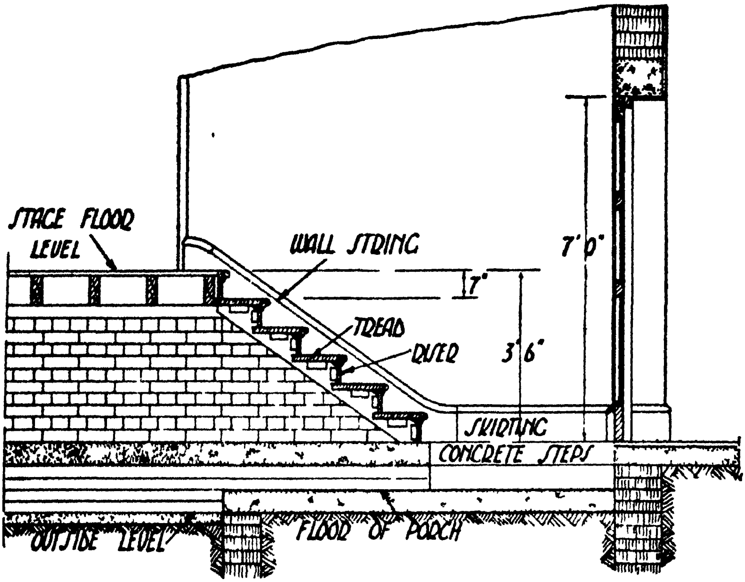
DOG-LEGGED STAIR FIG. 165



OPEN NEWEL STAIR FIG 166

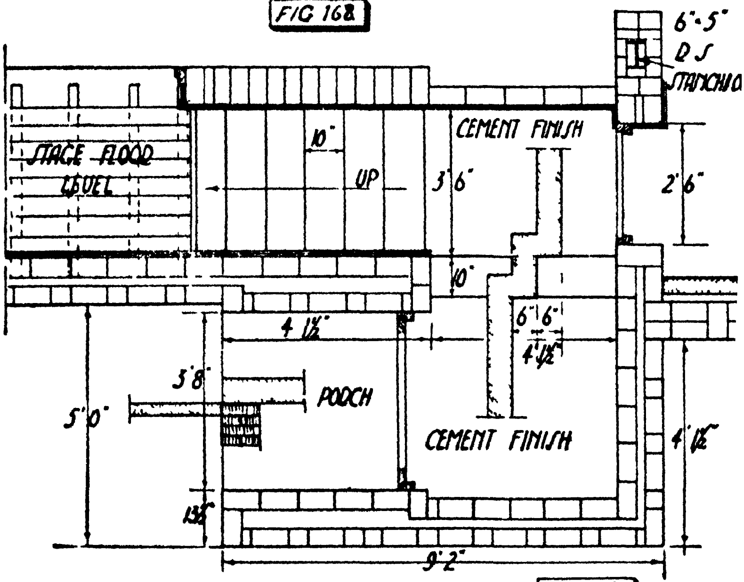


OPEN NEWEL STAIR WITH WINDERS FIG 167



SECTION THRO' STAIRS TO RETIRING ROOMS

FIG 168



PLAN OF PORCH AND STAIRS FIG 169

Wall Strings are the inclined pieces of timber which are adjacent to the wall and support the wall-end of the steps, as shown in Figs. 170–174.

Outer Strings are the inclined pieces of timber which support the steps at their end farthest from the wall. A section through an outer string is given in Fig. 175.

Rough Strings or Carriages

Wide stairs are strengthened by introducing intermediate supports between the wall and outer strings.

These supports are termed 'rough strings' or 'carriages,' and they may be notched to accommodate the treads and risers, or bracketed with rough pieces of wood.

The brackets are nailed to the carriage piece so that their upper ends coincide with the underside of the treads, as shown in Fig. 173.

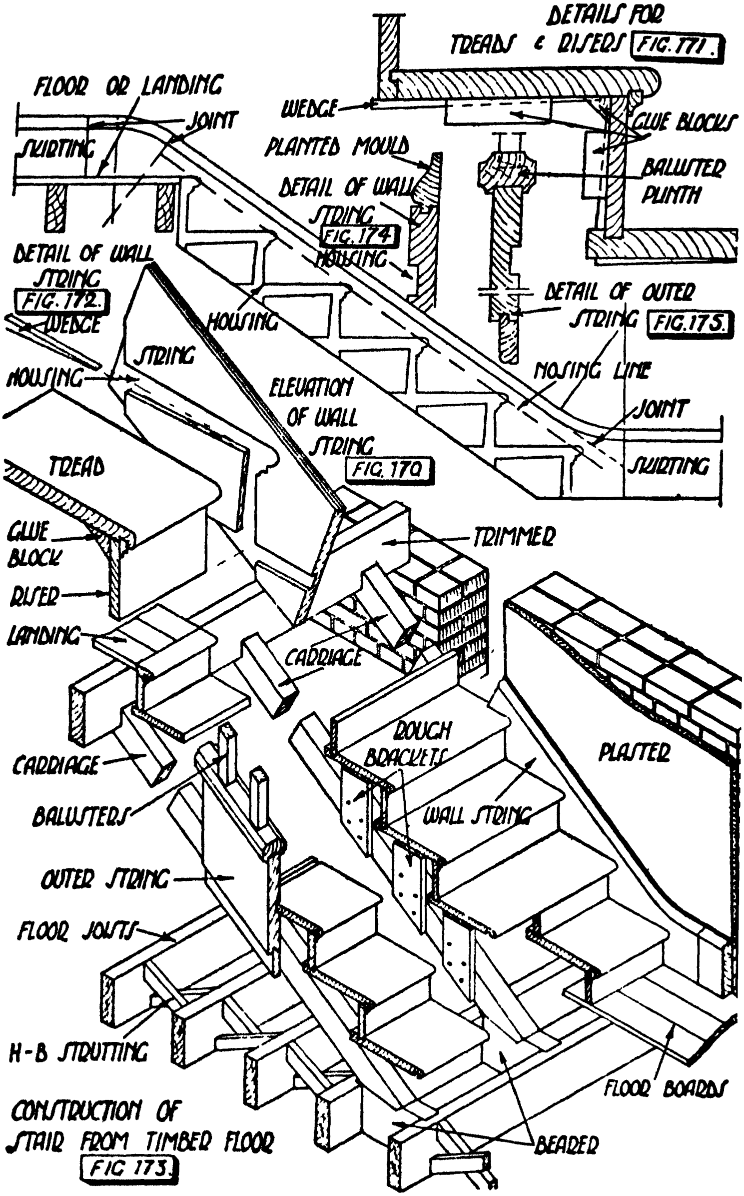
When wood stairs commence from a wood joisted floor the lower end of the carriages are tenoned into the floor-joists to resist the lateral thrust of the stairs. If the direction of the floor-joists is at right angles to the going of the stairs, it becomes necessary to frame the floor-joists and this may be done by inserting stiffeners or bearers between them for the support of the lower ends of the carriages, as shown in Fig. 173. When a landing forms part of a wood stair the upper ends of the carriages are usually jointed against one of the trimmer joists which supports the landing, as shown in Fig. 173.

Stone and Concrete Block Stairs

Stone and concrete stairs may be preferred to wood in circumstances where hard wear is expected, but they are essential in a building of a fire-resisting character.

Stone and concrete stairs are heavy and usually require walls for their support; the simplest method of construction is obtained by building both ends of the steps in a wall as shown in the sketch of the steps leading down to the heating chamber of the Assembly Hall, Fig. 9.

In this example the steps are rectangular blocks of stone resting upon each other.


DETAILS FOR TREADS & RISERS FIG. 171.
FLOOR OR LANDING
JOINT
SKIRTING
WEDGE
PLANTED MOULD
GLUE BLOCKS
BALUSTER PLINTH
DETAIL OF WALL STRING FIG. 174
HOUSING
DETAIL OF WALL STRING FIG. 172.
WEDGE
HOUSING
STRING
HOUSING
DETAIL OF OUTER STRING FIG. 175.
NOSING LINE
JOINT
SKIRTING
ELEVATION OF WALL STRING FIG. 170
TREAD
GLUE BLOCK
RISER
TRIMMER
LANDING
CARRIAGE
CARRIAGE
ROUGH BRACKETS
PLASTER
BALUSTERS
WALL STRING
OUTER STRING
FLOOR JOISTS
H-B STRUTTING
FLOOR BOARDS
BEARER
CONSTRUCTION OF STAIR FROM TIMBER FLOOR FIG 173.

Spandrel Steps (Fig. 10)

These steps are used where head-room and a good appearance from the flight of steps below are desired.

The under surface of each step is worked to form a raking soffit and to the same pitch as the stairs. This splayed surface should be worked to the wall face, the remaining part of the step being left rectangular, so as to form a horizontal seating on the wall.

The bearing surface of one step upon another should be worked in the form of a rebate so as to transmit the pressure from one step to another and to prevent any lateral or sliding movement of the steps.

A sketch of a spandrel step showing these bearings surfaces is given in Fig. 11.

Treads and Risers

Entrance stairs are often formed with a concrete core and covered with stone or marble slabs, the steps being built-up with treads and risers in a manner similar to wood stairs and as shown in Fig. 12. The slabs should be bedded on mortar pads and the joints dowelled.

Stone treads with tile risers are shown in the construction of the steps leading up to the Entrance Doorway of the Assembly Hall, Fig. 56

CHAPTER XX

DRAINAGE WORK

LOCAL by-laws require that plans showing the comple drainage lines for an intended drainage scheme shall l deposited with the local authority before permission is giv to erect a building.

These plans must indicate the provision for the ventilatic of the drains, position of water-closets, sinks, wastes and tl position of any sewer to which the drainage system is to l connected.

Separate Systems

When the surface water is to be excluded from the sewag drain and conveyed from the precincts of a building by separate system of pipes, the building is said to be draine by a separate or dual system of drainage.

A lay-out plan for a separate system of drainage for th Assembly Hall, is given in Fig. 176.

Combined Systems

When the rain and surface water is admitted into the sewage drain the system is said to be a 'combined' system. A separate system is more costly than a combined system owing to the duplication of the lines of pipes, and some authorities prefer the combined system because the admittance of rain and surface water into the sewage drain ensures better flushing and cleansing and consequently the drains are less likely to become foul.

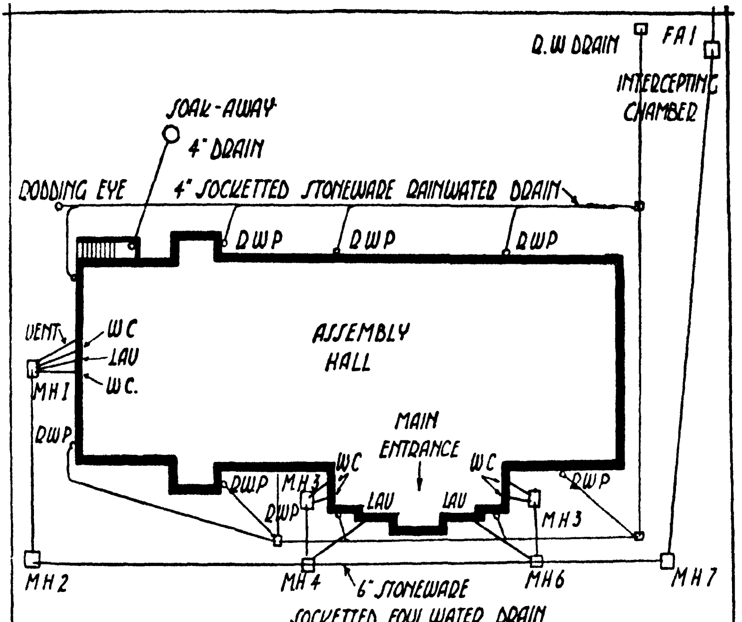
Excavations

Trenches for drains should be excavated to the required gradient, which is determined by the use of sight rails and

boning rods, the sides of the trenches being timbered as explained in Chapter I.

Laying Drains

Stoneware pipes should be laid on a continuous bed of concrete and to a gradient that will ensure the self cleansing of the pipes.



LAYOUT OF SEPARATE DRAINAGE SYSTEM FIG 176

The concrete should be at least 15" wide for a 4" diameter pipe, and 18" wide for a 6" pipe, and 4" thick, and the pipes laid in straight lines between points of access so that they are open to inspection when desired. When a length of pipe has been placed in position, the pipes should be 'flaunched' or 'benched-up' on each side with concrete, as shown in Fig. 180.

It is preferable to keep this benching short of the sockets

of the pipes, so that the joints can be examined during the testing process.

When stoneware drain pipes are laid under buildings or carriage ways they should be encased in concrete as shown in Fig. 181.

Jointing Stoneware Pipes

The joints in stoneware pipes should be carefully made with Portland cement and finished on the outside with a bold fillet, and a ring of gaskin or hemp yarn, steeped in Portland cement grout, should be placed in the bottom of the space between the two pipes. A detail of a joint between two stoneware drain pipes is given in Fig. 177.

The minimum thickness and depth of sockets for stoneware pipes are regulated by British Standard Specifications Nos. 65, 539 and 540.

There are various types of spigot ends for stoneware pipes, each having their own peculiar characteristics, but chiefly they consist of rings of bituminous material cast on the jointing surfaces of the pipes, and the space between the rings filled with Portland cement grout.

Cast-iron drain pipes are being used very considerably in preference to stoneware pipes, chiefly because they are cast in longer lengths and therefore require fewer joints.

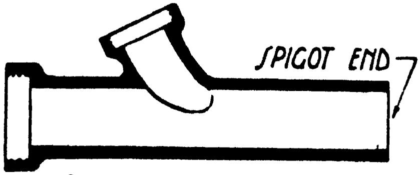
The quality and thickness of cast-iron pipes should conform to B.S.S. 437, but it is not intended to include a description of these in this volume.

Gradient for Drains

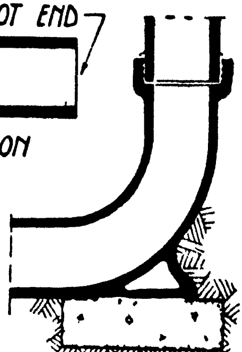
A common rule for determining the gradient for drains may be expressed in feet, as ten times the diameter of the drain in inches, viz:

4″ drain, gradient 1 in 40′.
6″ drain, gradient 1 in 60′.

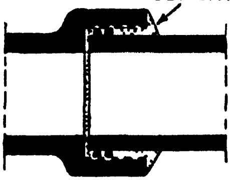
No advantage is to be gained by using pipes of too large diameter, and for this reason 4″ pipes are usually adopted for house drains.



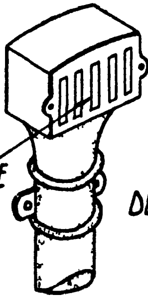
SECTION THRO' JUNCTION
FIG 178



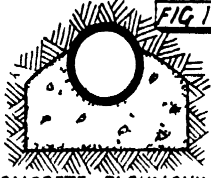
CONNECTION AT FOOT OF SOIL PIPE
FIG 179



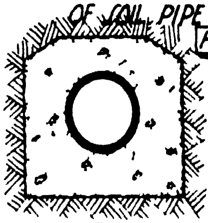
DETAIL OF PIPE JOINT
FIG 177



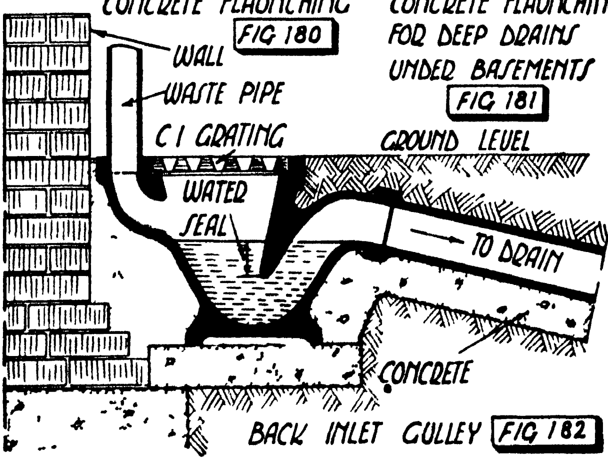
INLET GRATING WITH MICA VALVE
FIG 183



CONCRETE FLAUNCHING
FIG 180



CONCRETE FLAUNCHING FOR DEEP DRAINS UNDER BASEMENTS
FIG 181



BACK INLET GULLEY FIG 182

Junctions

A section through a junction pipe is given in Fig. 178. The eye for the intersecting pipe should be obliquely inclined in the direction of the flow, and not square or at right angles to the flow, as this type of junction is used only as a means of access to the drain.

The bend connection shown in Fig. 179 is termed a 'rest bend' and is usually placed at the foot of a soil pipe.

The fitting is provided with a flat base so that any weight which may be transmitted to it from the soil pipe, or caused by the impact of falling water, may be distributed over a fairly large area of the concrete base.

Traps

A trap consists of a bend in the pipe that is arranged so as to collect and retain liquid to such an extent that the passage is entirely filled.

The effectiveness of a trap depends upon the depth of water from the surface to the lowest part of the pipe which projects into the water and termed a *seal*. A section through a back-inlet gulley indicating the water seal is shown in Fig. 182.

The depth of the seal ranges from 1½" to 3" and it is important that these depths are maintained, otherwise gases from the drain will tend to pass through the trap into the premises.

The seal may be broken by siphonic action brought about by the formation of a partial vacuum in the pipes, or by suction which may be caused by a flow of water passing down the main pipe.

Siphonage may be prevented by an effective ventilation of the trap.

The water level of a trap may be reduced by evaporation or by capillary siphonage, resulting from the presence of a piece of rag or similar substance, part of which is in the trap and part hanging down the outlet.

Gulley Traps

Gulley traps are used for the reception of rain and surface water which may be discharged over the cast-iron gulley grating or under the grating and through a back-inlet.

The latter is preferable, as the flow of water is not interrupted by the sharp edges of the iron grating and ensures a complete cleansing of the trap by each discharge of water.

A well-designed gulley trap should be shaped so that solid matters are retained in the trap. A detail of a back-inlet gulley trap is given in Fig. 182.

Gulley traps should not be placed at the foot of a vent or soil pipe as such pipes should discharge direct into the drain and through a rest bend, a detail of which is given in Fig. 179.

CHAPTER XXI

DRAINAGE WORK (*Continued*)

Inspection Chambers and Manholes

THE object of building inspection chambers and manholes is to give facilities for examining the inside of the drain which is buried in the ground.

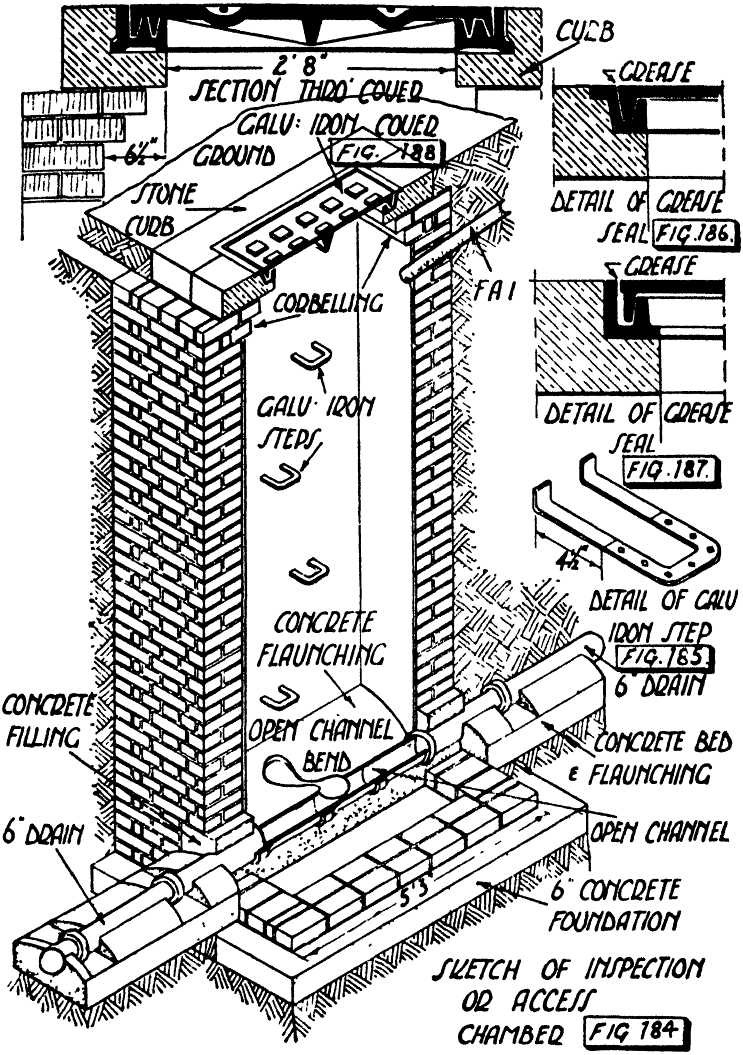
If any obstruction in the drain should occur they permit the introduction of rods for its removal, and for this reason, the chambers should be placed at each change in the direction of the drain, so that the pipes between the chambers are in a straight line. Manholes are usually constructed of brickwork built in cement mortar and on a concrete foundation, but they may be constructed with concrete throughout, if preferred.

Unless well vitrified bricks are used in the construction of the walls, the inside surface of the walls should be rendered in Portland cement mortar. The chamber should be large enough to admit the rods for the clearance of the drains, and when the depth exceeds 3′, iron steps should be built in the walls of the chamber to facilitate access to the bottom of the chamber.

A detail of a galvanised iron step is given in Fig. 185, and their position is indicated in Fig. 184.

The drain in the chamber should be formed of stoneware channels, U-shape in section, and when branch drains lead into the flow of the main channel, special curved branch channels should be built into the concrete flaunching and connected to the branch drains.

The bottom of the chamber should be benched up with concrete with sufficient 'fall' to enable splashings to be returned to the open channels. A sketch showing the construction of a brick inspection chamber, or manhole, is given in Fig. 184.



SKETCH OF INSPECTION OR ACCESS CHAMBER FIG 184

Chamber-covers

When inspection chambers are built as part of a stoneware drainage system, they should be covered with a metal cover, set in a metal frame.

The joint between the cover and the frame should be made air-tight by forming a single or a double seal, as shown in Figs. 186, 187 and 188.

To render the joint air-tight the recess in the frame is filled with grease or a non-drying plastic material.

A section through a manhole cover with a double grease sea is given in Fig. 188.

Intercepting Chambers and Traps

Under some building by-laws the drainage systems o buildings are required to be disconnected from the public sewer by the installation of an intercepting trap placed withir the curtilage of, and as far as practical from, the building.

The object of this trap is to prevent the transference o gases from the sewer through the drains into the building.

Some authorities, however, contend that the disadvantage of intercepting traps outweigh their advantages, and the drains are allowed to be connected to the sewer without ar intercepting trap.

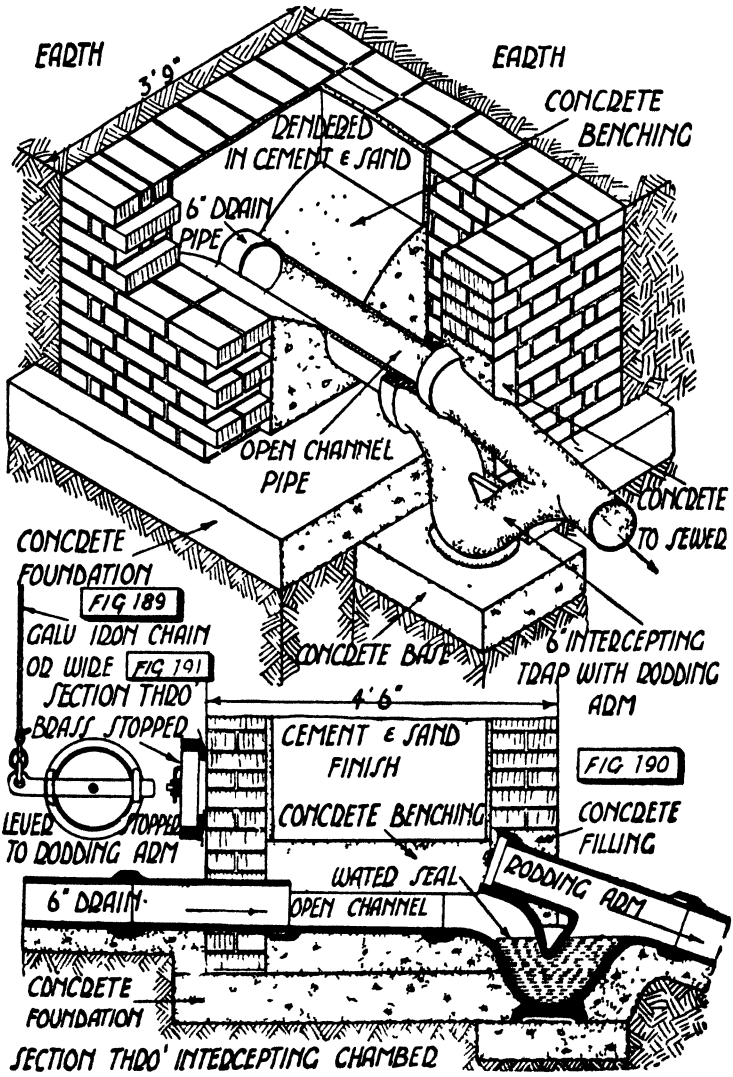
It is claimed that it is better to allow the sewer gases to be dispersed through the medium of the drainage systems o individual buildings.

Fig. 190 is a section showing the construction and fittings for an Intercepting Chamber and Trap.

The trap should be fitted with a 'rodding arm' leading direct into the drain which is connected to the sewer.

The mouth of the 'rodding arm' should be situated within the chamber and provided with an air-tight stopper which can be removed if desired without descending into the chamber. A detail of the rodding arm stopper, showing the fastening lever, is given in Fig. 191.

A sketch showing the construction of an Intercepting Chamber and Trap is given in Fig. 189.


EARTH
EARTH
3' 9"
RENDERED IN CEMENT & SAND
CONCRETE BENCHING
6" DRAIN PIPE
OPEN CHANNEL PIPE
CONCRETE
TO SEWER
CONCRETE FOUNDATION
FIG 189
CONCRETE BASE
6" INTERCEPTING TRAP WITH RODDING ARM
GALV IRON CHAIN OR WIRE
FIG 191
SECTION THRO' BRASS STOPPER
LEVER TO RODDING ARM
STOPPER
4' 6"
CEMENT & SAND FINISH
FIG 190
CONCRETE BENCHING
CONCRETE FILLING
WATER SEAL
RODDING ARM
6" DRAIN
OPEN CHANNEL
CONCRETE FOUNDATION
SECTION THRO' INTERCEPTING CHAMBER

Soil and Waste Pipes

Soil pipes are those which are intended for carrying the wastes from closets and urinals. These pipes are usually circular in section and fixed to the outside walls of buildings, unless special ventilated ducts are provided within the building for the accommodation of the pipes, in positions that are accessible.

Cast-iron soil pipes are in general use, but lead pipes should be used for the portions which connect the soil and waste pipes to the sanitary fittings, which are fixed within a building.

Ventilation of Drains

The top of all soil pipes should be carried well above the eaves of a roof or above any adjacent window opening, so that the gases, which may escape through the open end of the soil pipe, will not drift directly through the openings into the building.

Soil pipes should terminate just below ground level and be connected to a 'rest bend,' a detail of which is shown in Fig. 179, and thence direct into a Manhole or Inspection Chamber. This arrangement will allow a free passage for the air to pass up the soil pipe, thus permitting the whole of the drainage system to get the benefit of the ventilation.

If provision is essential for air to pass freely out of the drainage system, provision also must be made for fresh air to enter the system.

This is usually done by building a fresh air inlet (F.A.I.) pipe in the top part of the walls of the manholes as shown in Fig. 184.

The pipe is continued under ground to a convenient point, such as an adjacent wall, where it is terminated by means of a fresh air inlet grating. A sketch is given in Fig. 183.

A hinged mica sheet is fitted inside the grating, and this allows the ingress of air and closes the aperture directly egress air-currents occur. Cast-iron rainwater and soil pipes are secured to wall surfaces by means of independent holdfast clips or lugs which are cast on the sockets of the pipes as shown in Figs. 201 and 202. The joints of cast-iron soil pipes should

be made by inserting a ring of lead wool or tarred yarn in the space between the pipes, and then filling with molten lead, which should be properly caulked. A detailed section through a cast-iron soil pipe showing the socketed joint is given in Fig. 195.

Waste pipes are the pipes which lead from sinks and lavatory basins and baths for the discharge of the waste water into down pipes or direct into gulleys. They should be provided with an 'S' or 'P' trap fixed as close to the fitting as possible to prevent any foul air entering the building through the medium of the fitting.

When more than one fitting is connected to a main waste pipe, the trap of each fitting should be ventilated by the inclusion of an anti-siphonage pipe.

The size of waste pipes varies, but for ordinary sink and lavatory wastes a 2″ pipe is usually sufficient.

A sketch showing the connections of a waste pipe leading from a sink into a back inlet gulley is given in Fig. 199.

Rainwater Shoes

When a separate system of drainage is adopted, as shown in the plan Fig. 176, gulley traps are not necessary at the foot of the rainwater pipes, but for cleaning purposes and for the retention of solids which are liable to be brought down with the rainwater from the roof, a rainwater shoe may be used as shown in Figs. 201 and 202.

Sanitary Fittings and Internal Plumbing

Having discussed very briefly the essential points in connection with drainage work that is exterior to a building, we may now discuss the internal fittings as part of drainage work.

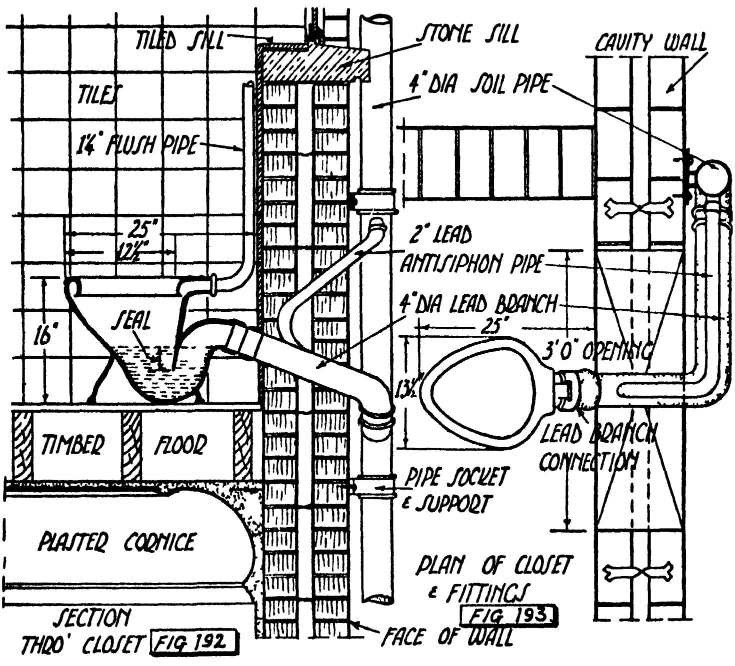
Water-closets are the most important sanitary fittings in buildings and local building by-laws regulate their position in buildings, including the provision for the ventilation of the compartment which contains a water-closet.

There are several types of closet-pans and these may be summarised as: (1) Washdown closets; (2) Siphonic closets;

(3) Health closets. The first type is in most common use and will be described here.

The pan should be made of a glazed non-absorbent material and of such a shape that it is easily cleansed by the flushing action of the water from the water waste preventer.

The water circulates through the flushing rim of the pan



SECTION THRO' CLOSET FIG 192

PLAN OF CLOSET & FITTINGS FIG 193

which is connected to the flush pipe leading from the water waste preventer.

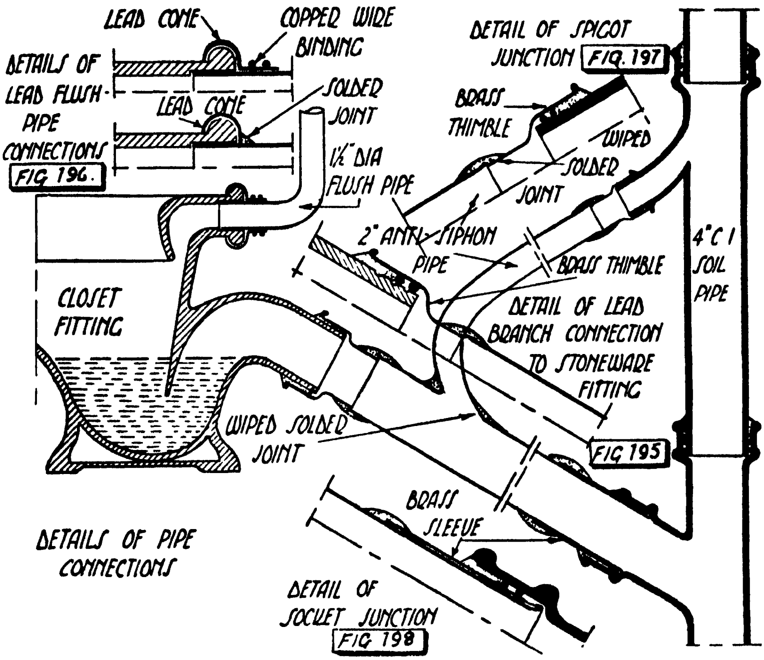
A sectional detail through a wash-down closet, situated on an upper floor and against a cavity wall, is given in Fig. 192.

The area of water in the pan should be as large as possible and the depth of the seal about 2½". The seat should be approximately 16" above the floor and the front of the pan 25" from the wall face. Details of the various joint connections between a wash-down closet pan and soil and flush pipes are given in Figs. 194–198.

Anti-siphonage

The seal in a wash-down closet pan is liable to be broken by the water being drawn out of the trap by siphonic action, caused by the formation of a vacuum in the pipe.

This action may be checked by fitting an anti-siphonage pipe in the position shown in the sections. Figs. 192 and 194.



If two or more water-closets are connected to the same soil pipe, the trap of each closet should be ventilated into the open air by connecting an anti-siphonage pipe to the soil pipe at a point above the highest sanitary fitting, or a separate anti-siphon pipe may be carried up in a manner similar to a soil pipe.

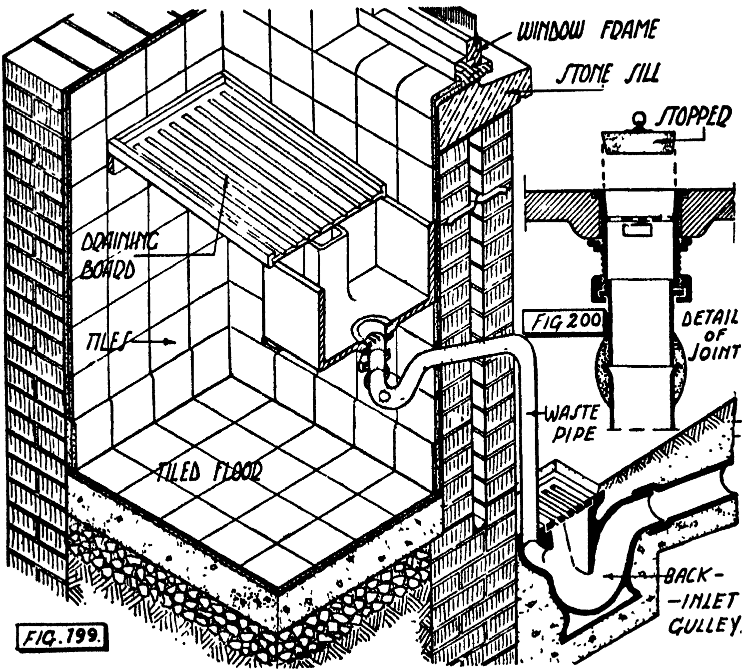
Sinks

These fittings are best fixed against an external wall and under a window opening, so that the maximum amount of

light is obtainable over the fitting and in order to reduce the length of the waste pipe to a minimum.

A sketch showing the construction and fitments for a scullery sink supported against a cavity wall, is given in Fig. 199.

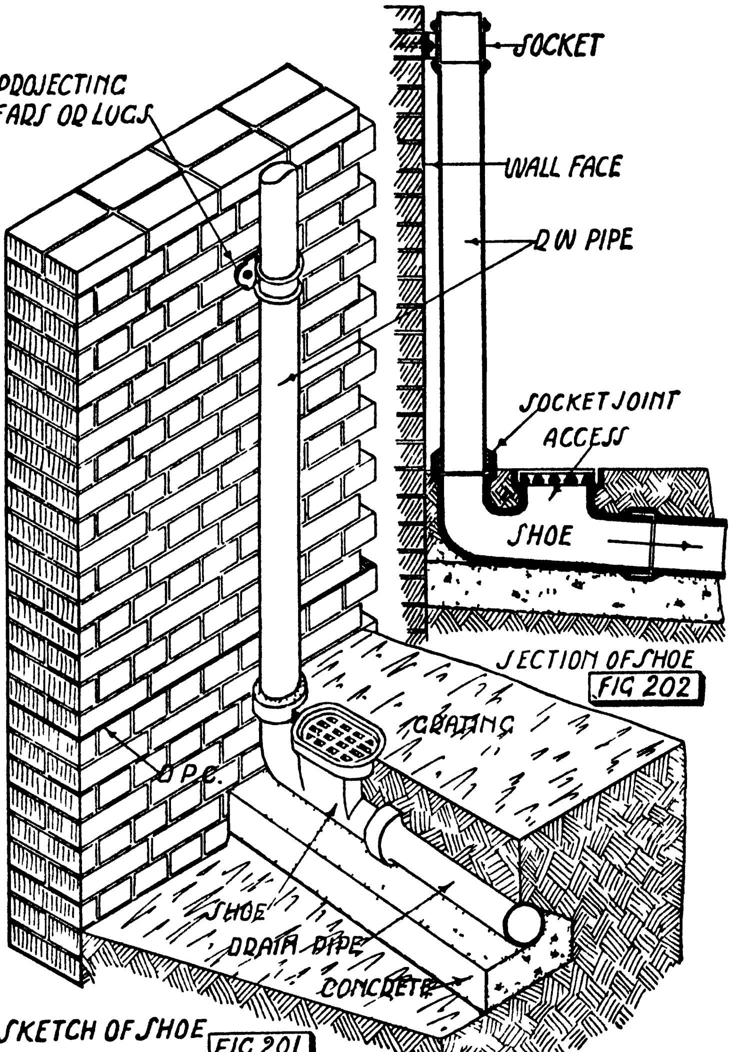
The sketch shows a glazed fire-clay or earthenware basin fitted with an overflow channel which connects to the brass



connection of the waste pipe; a detail of the joint is given in Fig. 200.

The floor and walls surrounding the sink are lined with tiles and a teak draining board is shown fitted at the side of the sink.

Extensive developments have taken place in regard to the design of sinks and it is now common practice to fit a Butler's type of sink in domestic premises in preference to the ordinary type of sinks. Sinks are now available in 'stainless steel' and 'Monel metal.'



SECTION OF SHOE
FIG 202

SKETCH OF SHOE FIG 201

Drain Testing

It is important that drains should be tested to ascertain if the joints are water-tight and that no sewage is leaking from the drain.

A new drainage system should be tested before the pipes have been covered with earth and the trenches filled in. There are several methods of testing drains, the chief ones being [1] by water; [2] by air; [3] by smoke.

The following notes are a brief outline of the operation of the tests:

Water Tests.—The only reliable method of testing a drainage system is by the application of water pressure within the system. This may be done by stopping the lower end of the drain by inserting an expanding plug, or air-inflated bag, and filling the portion of the system to be tested, with water, up to the level of the gulleys which should be plugged or stopped with one of the many devices obtainable for this purpose.

A test pressure of not more than 6′ head of water may be obtained by fixing a special connecting device fitted with a scale which will register the amount of leakage within a given time, or a bend and a suitable length of pipe may be fixed temporarily in a vertical position at the higher end of the section so as to secure a sufficient head of water.

The drain should be filled with water and 15 minutes allowed for any absorption to take place, and when this loss has been made up, the pipes should be left under pressure for an hour.

Any appreciable sinkage of the water level as indicated on the scale, or noticed in the vertical stand-pipe, will indicate a leakage which should be remedied.

Air Tests.—In applying this test it is necessary to close the ends of the soil and vent pipes and the other portions of the drain, as described previously.

The air is pumped into the drain through an air-pipe which is attached to one of the stoppers, the pressure being measured by readings on a U-gauge Manometer, which consists of a bent open-ended tube to which is attached a scale.

The gauge is filled with water up to the zero scale on each

leg of the U, and when the pressure is applied, it will depress the water on one side of the gauge and elevate it on the other side.

The difference in the level of the water will register the head pressure. If the water in the gauge remains stationary, the drain may be considered to be satisfactory, but a fall in the level of the water will indicate a leakage.

Smoke Test.—This test is best applied by forcing smoke into the drains by means of an apparatus fitted with a bellows device, and connected to a smoke chamber situated within the apparatus.

The smoke, which is generated by burning oily waste, or other similar substance, is allowed to pass through the stopper which is fitted into the drain at its lowest end, or nearest to an inspection chamber.

As soon as the smoke is seen to issue from the top of the soil or vent pipes, they should be closed or stopped, so that a slight pressure of smoke-laden air is maintained in the drainage system.

If there are any serious leaks smoke will be seen issuing therefrom.

Smoke rockets, consisting of cylindrical cardboard cases charged with material which gives off dense and pungent smoke, may be used for this test.

The rockets are ignited and inserted through a trap, with the end of the rocket above the surface of the water in the trap. In the case of water closets situated on different floors, a rocket should be inserted in each trap and left for about ten minutes before being withdrawn.

CHAPTER XXII

MATERIALS

Iron and Steel

IRON is used in buildings in three forms, viz: Wrought iron, W.I.; Cast iron, C.I.; and Mild steel, M.S.

Wrought Iron

Wrought iron is the purest form of commercial iron, contains less than 0·2 per cent. carbon, and is obtained by extracting carbon from pig iron and then passing the metal through a process of hammering and rolling. Since it contains very little carbon, it is tough, ductile, easily wrought and welded; and is characterised by its malleability.

It is used very considerably for metal lathing, wrought metal work, grills, gratings, gas and water pipes and heavy door and window furniture.

Manufacture.—Wrought iron is made by melting pig iron containing a high percentage of silicon which assists in forming a fluid slag over the molten iron during melting processes and protects it from oxidation by the air. This process is carried out in a puddling furnace which comprises a shallow hearth lined with basic iron oxide in the form of a high-grade ore.

As the metal approaches a state of purity its melting point rises from about 1,200° C. to 1,600° C., and as the temperature attained in the furnace does not rise to this limit the metal becomes pasty and is rolled into balls termed 'blooms,' taken from the furnace and placed under a mechanical hammer.

The rolling processes which follow tend to elongate the particles of iron and slag, thus creating a fibrous structure which is a characteristic of wrought iron.

Cast Iron

Cast iron is high in compressive strength but low in tensile strength, and although this product is almost entirely superseded by mild steel for structural purposes, it is used very considerably in the manufacture of many articles connected with buildings, such as rainwater pipes, vent pipes, gutters, drainage fittings, etc.

Manufacture.—Cast iron is made by remelting a combination of pig iron and scrap iron by the aid of fuel which is mixed with the metal in a furnace, termed a cupola, and contains from 1·5 to 3 per cent. of carbon.

The percentages of sulphur, manganese and silica will affect the physical properties of cast iron by rendering it harder or more or less brittle; consequently the process of remelting will assist in combining the pig iron with the scrap iron of different compositions and so produce a cast iron with the required percentage of each ingredient.

The molten metal is run off into sand moulds and castings as required.

Steel

There are various kinds of steel viz: Tool steel, Spring steel, Special steels and Mild steel, the latter being the most important metal from a structural engineering point of view.

Mild steel is rolled into bars, flats and structural steel shapes and contains between 0·2 and 0·3 per cent. carbon and should comply with the B.S.S. '*for the use of structural steel in building*' No. 449 (1935). Carbon is a very important ingredient in the composition of steel, rendering it harder, less ductile and more brittle; therefore its proportion must be carefully controlled.

Mild steel is made chiefly by the 'Siemens' or 'open hearth' processes, in which pig iron, iron ore and calcined limestone, are fed on to a large open hearth and heated by powerful gas furnaces. The oxidation of the carbon and silicon is effected partly by the oxidising atmosphere and partly by the addition of iron oxide.

The gas is admitted through an inlet at one end of the furnace where it ignites by mixing with pre-heated air which is admitted through another inlet.

The hot gases pass over the surface of the metal and the heat is absorbed through the layer of molten slag which protects the iron from loss through oxidation. The slag is formed by the iron ore combining with the phosphorous, manganese and silicon to form oxides, which unite with the limestone.

When the molten metal is refined to the required degree, it is poured into ladles and finally into moulds to be shaped into ingots which are later reheated and passed backwards and forwards through rollers, the shape of which corresponds with the outline of structural shapes. This rolling process tends to improve the quality of the steel by adding strength and ductibility.

Bricks

A general classification of bricks and an outline of their characteristics were given in Vol. I. When selecting bricks, the particular purpose for which they are required must be considered. For facing work the colour and texture will be of great importance, while bricks which are required for foundation work and interior load bearing walls must be sound and well vitrified.

Facing Bricks

Facing bricks are more porous than other kinds but their success is determined by the artistic qualities they possess and the manner in which they harmonise with their surroundings.

Sand-faced bricks are not suitable for use in atmospheres which are inclined to be soot laden, or in any very exposed positions, because their texture tends to encourage the adherance of sooty particles to the facings, and they are usually porous in character and liable to absorb moisture.

Colour.—The colour of bricks will depend upon the composition of the clay, the temperature at which they are burnt

and the foreign substances which are present or added during burning.

A pure clay, free from iron, will produce a whitish brick, while the addition of oxide of iron will cause the colour of the resulting brick to be reddish-brown to red.

A blue to purple colour may be obtained by adding oxide of iron and subjecting the bricks to intense heat so that a vitrified character is obtained, the red oxide of iron being converted into black oxide when fused with silica.

Manufacture.—Hand-made facing bricks are made from Malm, or prepared Malm, in which the constituents are proportioned to give the best results.

The clay is mixed in a wash mill with a proportion of chalk to produce the correct consistency.

When the mixture has been reduced to a creamy substance, it is passed through gratings and allowed to settle in large pits or tanks until it is almost solid; it is then covered with cinders and allowed to remain during the winter.

The clay and cinders are removed from the pit and thoroughly mixed in a pug-mill.

The kneaded mixture is next shaped by hand in wood or metal moulds.

The moulds are placed on a stock board, which is made to fit the bottom of the mould and upon which is a raised projection which forms the frog, or indent in the bed of the brick.

The clay is pressed into the mould and the top surface struck off.

If sand is sprinkled over the mould the process is termed 'sand moulding.'

As the bricks are moulded they are stacked in drying sheds or 'hacks' where they remain until quite dry and afterwards burnt or baked in kilns.

Fletton Bricks

Manufacture.—The clay or shale for making pressed bricks is usually obtained from the stratum in the quarry by a mechanical digger which scoops up the raw material and drops it into trucks.

These trucks convey the raw material to grinding mills where it is ground and afterwards elevated to circular revolving screens, the fine material dropping on to a conveying belt and the coarse material returned to the mill for regrinding.

The belt consists of a plain steel band with driving terminals, and arranged to run over pulleys at each end. This belt carries the ground shale to a position over the machine presses, where it is diverted off the belt into hoppers which feed the brick pressing machine. The raw pressed bricks are placed in a Hoffman kiln chamber, and stacked, so that they are about an inch apart, thereby allowing hot air to circulate between them. The kiln chambers are connected to each other and slowly warmed, fired, and allowed to cool in rotation, so that the bricks in one chamber are being burnt while those in the next chamber are being warmed up by the waste heat from the first chamber. While this process is going on the chambers behind are being cooled off ready for charging purposes.

The most modern type of Hoffman kiln has approximately 75 chambers, which are arranged in plan in the form of a U, each chamber being semi-circular in vertical section and about 55′ long × 16′ wide and 9′ high.

The fire-holes, which are used for lighting-up, are situated at each end near ground level, and the heat travels from chamber to chamber.

Feed-holes about 6″ square are situated in the curved roof of each chamber and extend to a flat roof above the kiln.

Coal-dust is fed down these feed-holes, which also act as observation eyes to ascertain if the bricks are sufficiently burnt.

The maximum temperature to which the bricks are subjected is about 1500° F.

When the chamber has been filled and the entrances sealed, it is slowly heated and fired, the period allowed for this process being about seven days, and another six days are allowed for cooling before the bricks are removed and loaded into railway trucks or motor lorries for despatch to the site.

Roofing Tiles

Manufacture.—The process of manufacture of roofing tiles varies considerably according to the locality, kind of clay, type of tile and its finish.

The clay is usually taken from open pits after the top soil has been removed, and it may be suitable for use as it occurs in the pit, or it may have to be blended with sand and other material to produce a suitable mixture.

In some pits a blend of the clays from separate deposits will produce the required constituents. The clay is spread and left exposed for a period, and this will result in the breaking down of the lumps and allow chemical changes to take place. This process adds plasticity to the clay and improves the quality of the finished tile.

After exposure the clay is conveyed to a mill where it is ground by being passed through rollers. This grinding process is essential because large particles of clay will impair the quality of the finished tile. After this process, a certain amount of water is added and the mixture is conveyed to a pug-mill, where it is mixed into a paste of uniform consistency and the required plasticity is reached.

The pugged clay is then stored, so that the moisture in the clay becomes more evenly distributed throughout the mass.

When required for use it is cut into suitable size slabs and conveyed to the moulding sheds, where the tiles are moulded by hand or in machine presses.

The raw tiles are stacked in drying sheds where they are allowed to remain until the moisture in the clay has dried out.

This drying process exposes any defects in the constituents or mixing and will result in the appearance of cracks, the defective tiles being thrown out and returned to the grinding plant, before being burnt. Burning is usually carried out in kilns of an intermittent and cupola type and where the control of the temperature of the kiln is left to the judgment of the attendent.

In some instances the tiles are burnt in Hoffman kilns in a manner similar to bricks and at a temperature of 900° C.

Drainage and Sanitary Ware

Stoneware is produced by burning plastic clays of the lias formation in kilns in a manner similar to fire-clay goods, but at a higher temperature. Although these clays contain a large percentage of silica it is usual to add extra sand, ground flint, and crushed stoneware to the clay to prevent excessive shrinkage in burning.

Stoneware is hard, essentially vitreous, and impermeable throughout, the finished surface being produced by a process of salt glazing which usually produces a deep brown colour.

It is used very considerably in the manufacture of drain pipes, traps, gulleys, etc.

Manufacture.—Drain pipes are burnt in down-draught kilns and stacked vertically with the sockets downwards and over the spigot ends of the pipes below. This procedure ensures that the salt glazing is less apparent on the spigot ends of the pipes, thereby providing a more suitable surface for the adherence of the cement jointing mixture.

Salt glazing is effected by throwing salt into the kiln during the process of burning, thus causing the heat to volatilise the salt, which creates a chemical transfusion and forms a film of glass on the surfaces of the articles within the kiln.

Sanitary Ware

Sinks, w.c. pans, lavatory basins and urinal stalls are usually made from a dense fireclay, earthenware or porcelain, which is tempered to a plastic condition, moulded, dried and burnt in kilns.

Good sanitary ware should be well glazed and impervious to moisture, and proof against any damage due to the expansion and contraction of the material brought about by the use of hot and cold liquids.

Plasters

Plaster of Paris is obtained by burning and grinding a mineral known as gypsum, which is hydrated sulphate of lime.

Gypsum is obtained from many districts, but it is abundant around Paris from whence the plaster derives its name; also

large quantities are obtained from Derbyshire and Staffordshire, and it is imported from other countries.

There are three grades of plaster of Paris, superfine, fine and coarse, and the varieties are known as pink or white, coarse or fine, quick or slow setting.

The setting time can be accelerated by the addition of *alum* with the gauging water or retarded by adding *size* to the water.

Manufacture.—The gypsum around Derbyshire is mined and brought to the surface, in lumps of various size, where it is picked and graded and foreign matter removed. The gypsum is burnt in kilns until all the water of crystallisation, which is a natural property of sulphate of lime, is driven off and the burnt product removed from the kiln and passed through a process of grinding until the required degree of fineness is obtained.

Plaster of Paris is used by plasterers as the bases for the finishing coats for all kinds of internal decorative work such as cornices, ceilings, panels, mouldings and ornamental work.

Keene's cement is prepared by recalcining gypsum after it has been soaked in a solution of alum.

It is made in two qualities, coarse and superfine. It sets harder than plaster of Paris and is therefore used very considerably for making up prominent angles, skirtings, dados, architraves, etc.

A mixture of 3 parts sand and 1 part Keene's cement may be used for rendering and floating walls in preference to a mixture containing Portland cement.

Parian cement is prepared in a manner similar to Keene's cement, but in this instance the calcined gypsum is saturated by a solution of borax, and then dried, re-heated and ground to the degree of fineness required.

It is used for the finishing coats of internal wall surfaces, sets quickly and produces a hard, smooth surface.

Sirapite is a form of plaster of Paris and is obtained by calcining a particular variety of gypsum, which is mined in large quantities at Kingston-on-Soar, Derbyshire. The gypsum which is used for the manufacture of Sirapite is a natural rock, impregnated with petroleum.

It is graded and broken into small lumps, burnt in kilns and afterwards ground.

It sets very quickly and on account of its hard setting properties it is used for wall surfaces and prominent angles and quoins.

When Sirapite is used for walls the surfaces of the walls may be plastered in two coats instead of three, the first coat being a mixture of 3 parts sand to 1 part Sirapite and a finishing coat of neat Sirapite.

Asphalt

The term "asphalt" applies to a number of manufactured products and includes compounds of bitumen and siliceous grits, but in its best form it consists of natural limestone impregnated with bitumen.

Bitumen is a mixture of hydrocarbons in a solid or viscous state occurring naturally or produced as a by-product from petrol refining processes, and is converted into asphalt by being mixed with natural limestones that are impregnated with bitumen.

Rock Asphalt is a natural limestone impregnated with bitumen and of a dark chocolate colour and quarried in a manner similar to building stones.

After quarrying, it is crushed, pulverised, and heated to a temperature of 150° to 200°.

Mastic Asphalt is the term applied to the material that is mostly used for various purposes in building construction.

It is manufactured from rock asphalt that has been crushed and pulverised, and rendered more fluid by the addition of bitumen and a proportion of clean siliceous grit.

After the process of heating, the mixture is moulded into blocks and in this state it is sent to the site of the proposed building where the blocks are broken up and reheated in a cauldron until it obtains a consistency of wet mortar.

While the mixture is in this heated and fluid condition it is spread in layers or plies over the prepared surfaces. Mastic asphalt is used as a means for waterproofing basements, forming damp-proof courses and coverings to flat roofs, gutters, etc.

Building Stones

Selection.—Owing to the variation in building stones the question of selection is one of great difficulty.

If durability alone counted in the selection of a stone the choice would be in favour of granite, but many other factors usually govern the choice.

The practical points to notice in choosing a stone are:

(1) **Limitations of the quarry** in regard to height of beds, dimension of blocks obtainable and the estimated output.

(2) **Texture,** if suited for the execution of the desired architectural details.

(3) **Situation of the building,** because some stones will withstand the effects of the atmosphere of an inland air, but when exposed to sea air, decay very rapidly.

(4) **Aspect.**—The stonework of a building facing south or south-west frequently shows signs of decay, owing to the sudden changes in temperature, due to the alternating periods of sunshine and rain.

(5) **Colour.**—A stone may be suitable in structure for a given purpose, but quite unsuitable in regard to colour and appearance.

Natural Bed

All stratified rocks, which include sandstones and limestones were deposited in layers from time to time.

This building up of the layers was accompanied by a variation of material, probably of an entirely different structure and composition.

The joints between these layers are termed the 'natural' bed of the stone.

In some stones the layers are visibly marked, and the direction of the layers can easily be determined, but in other stones the bedding planes cannot easily be distinguished and an intimate knowledge of the stone is required before a definite statement can be made as to the direction of the bedding planes.

The ends of the laminæ should be exposed when the stones are placed in their position in a building and the bedding planes of arch-stones should lie in a direction as near as possible normal to the curve of the arch.

The stones comprising cornices and overhanging courses with deep undercut members in their profile, may be placed on the walls of a building with the ends of the bedding planes vertical, but it is preferable to use specially selected stones and bed them on their natural bed with their bedding planes horizontal.

Durability of Building Stones

The conditions affecting the durability of building stones are varied and the precise cause of decay in any particular stone is often very difficult to determine.

There are two chief agencies that cause decay or destruction, each assisting the other, viz:

(1) Mechanical; (2) Chemical.

The chief mechanical agencies are: sand-borne winds, changes in temperature, frost, friction and rain.

Sand-borne winds have a distinct abrasive effect on the surfaces of stones, causing them to disintegrate.

Changes in temperature may cause the expansion and contraction of the particles, thus causing disintegration of the surfaces to take place.

Close-grained and compact stones are very subject to this action.

Frost.—Moisture contained in the pores of a stone is liable to become frozen and expansion will take place due to the freezing action which sets up stresses in the pores of the stone and results in the disintegration of the surfaces.

When freshly quarried, building stones contain moisture, which is a dilute acid with silica, lime and other deposits in solution and is termed 'quarry sap.' This moisture should be thoroughly dried out before the stones are placed in position on the wall of a building.

Friction is an abrasive action which causes the surfaces of the stones at the lower part of a building to be worn away.

Chemical Agencies

Chemical action is due mainly to the absorption of rainwater, charged with impurities taken up from the air and deposited on the surface of the stones. Acids act very readily

upon carbonate of lime, which is almost entirely soluble in water and crystallises out from solution.

This chemical action is associated with an alteration in the structure of the surfaces of a stone and is attended by a large expansion or crystallisation that results in the loosening of the particles, thus rendering them easily displaced by mechanical agencies.

Reconstructed Stone

Reconstructed stone may be uniform in composition throughout the mass, or it may comprise a surface layer from 1" to 1½" thick, composed of crushed or carefully graded natural stone and a proportion of white or grey Portland cement.

The aggregate contained in the surface layer gives character to the stone, but the quality will depend very largely upon the selection of suitable aggregates.

It is very important that the aggregate used in the concrete core is suitable for being used in combination with the constituents of the materials that form the structure of the surface layer.

Coke breeze, clinker, coal residues and slag may be considered doubtful aggregates, but materials consisting of crushed stone, inert rock, including granite, sand and gravel are suitable for this purpose.

Shrinkage is a defect resulting from the inevitable drying of the materials.

Manufacture

The methods of manufacture consist chiefly of wood moulding, metal moulding and sand moulding.

Wood Moulding.—Good moulds are essential if good casts are to be obtained and great care must be exercised to ensure that the moulds are true to shape and constructed so that they can be easily removed without injuring the cast. Wood moulds are very suitable for casting architectural units, mouldings, etc., as they can be adapted and built up to any requirement or detail.

The facing material is first placed in the mould to cover all the facing portions and to the required thickness, then the mould is filled with the backing concrete or core.

The materials should be placed in the moulds in a semi-dry state and tamped or rammed by a pneumatic hammer.

The distinguishing feature of this process of manufacture is that the facing material of natural stone is cast integrally with the backing material.

Metal Moulding.—This is similar to wood moulding, but the use of metal moulds is more suitable for standard and repetition units, such as kerbs, sills, copings, etc.

Sand Moulding.—Specially prepared loamy sand is spread to a varying depth over the floor area of a shed, and wood replicas are made to the size and contour of the units required.

These are placed in the sand face downwards so that they can be easily withdrawn after the sand has been tightly pressed round the mould.

This process will leave the sand to form the cast and into which the mix is poured.

As the sand is moist it does not tend to draw to the surface the moisture from the body of the mix, thus allowing the material to set with an evenness of cement throughout the mass. To assist in the removal and the lifting of the blocks, steel bars are placed in required positions before the mix is poured into the cast.

When the material has hardened, the blocks are removed from the moulds and stored for a period in a moist atmosphere or stacked in curing chambers, where they remain for a specified time in an atmosphere of predetermined temperature and humidity.

For steel and concrete framed structures, reconstructed stone is a particularly suitable facing medium, because it can be cast with the necessary grooves, sinkings and notchings for fitting into the contour of the steel sections or concrete beams.

Bolts and attachment devices can be cast in the blocks and left projecting for tying the stonework to the structural members.

Aggregates

Reconstructed stone may be considered to be a mass of concrete made by uniting Portland cement and water and fine materials such as sand, crushed stone (including granite), and clinker.

The chemically active element is the cement, which becomes hydrated by the addition of water and combines with the various materials, causing a hardening of the entire mass, which becomes like a solid block of stone. The cement content is termed the matrix and the other materials, such as sand, crushed stone, clinker, etc., are termed aggregates.

Aggregates for Concrete Floors

The weight of the concrete for filler-joisted floors and where strength is of secondary importance, may be reduced by using special light-weight aggregates, which may be of two types:

(1) Natural; (2) Artificial.

Under the heading of natural aggregates, pumice may be mentioned as the chief material.

Artificial aggregates may be burnt clay, slag or breeze or clinker.

Pumice is of volcanic origin; it is highly porous, light in weight and resists the action of frost very effectively.

It is fire-resisting, sound resisting and has good heat insulation qualities.

Because of these qualities, pumice may be used advantageously as an aggregate for concrete which is intended for the casing of steel structural members, filler-joisted floors, partition blocks, and the interior lining for external walls.

Breeze.—The term is used to cover various types of furnace residue, ranging from disintegrated clinker to burnt ashes. When coke breeze is specified the term should apply only to the coke residue produced by coke ovens or gasworks.

Clinker.—The term used for furnace ashes which have been heated in a manner that almost all the combustible matter has been removed.

Clinker is sometimes used for the manufacture of bricks and partition blocks.

Wall Boards

Sheets of material termed wall boards are being used for the covering of walls and ceilings, etc., and they are known chiefly by the proprietory names that prefixes the type of board.

Fibre-boards are made up of wood or other vegetable product which is finely shredded and synthesized into a homogeneous sheet and until it becomes a synthetic wood without grain.

The chief characteristics of fibre-boards may be said to be:

(1) They are less liable to movement under changes of temperature and moisture.

(2) Their power of insulation against temperature changes.

(3) Their sound-absorbing properties.

Fibre-boards may be used for many purposes in building construction, but their chief uses are the following:

(1) Internal permanent shuttering for concrete walls.

(2) Coverings to internal framework of partition walls, before applying a plaster finish, or they may be used for forming a finished surface if desired.

(3) As a means for covering wood joist ceilings, instead of wood laths, the sheets being nailed to the underside of the timber joists and plastered, if desired, in one or two coats.

When the boards are to be attached to the underside of a concrete floor, they should be nailed to wood battens, which should be fastened to the underside of the floor-slab.

(4) For insulating purposes in the construction of pitched and flat roofs. When used on pitched roofs they should be placed under the slates and tiles and used as a substitute for close boarding, but when they are used in flat roof construction of timber, the fibre-boards should be laid on top of the close boarding and the felt underlay of the roof covering laid direct on the fibre-boards.

If asphalt is to be used as the root covering it is advisable to cover the fibre-boards with roofing felt before applying the asphalt.

When used on flat roofs constructed with concrete the concrete surface should be coated with hot pitch and tar and the fibre-boards pressed into position and then covered with layers of felt and asphalt or bitumastic materials.

Jointing.—When fibre-boards are to form the surfaces of partition walls it is necessary to cover the joints between the boards.

There are three methods of joint treatment, but the success of the method will depend upon the decorative finish desired.

Where panelling is desired the joints can be covered with a cover fillet, but when a plane wall surface or ceiling is desired for the application of distemper or paint, a thin fibre strip can be used with the jointing material.

Another method is the use of a special joint filler in conjunction with a very fine open-weave tape. This will assist in reinforcing the joint and prevent the likelihood of hair cracks which might occur owing to the drying out of the various building materials.

Cork-board used in building construction for insulation purposes can be obtained in various thicknesses to suit particular requirements. It is manufactured from granules of pure cork which are compressed into slabs and baked.

During this heat treatment the natural resin in the cork is liquefied and tends to bind the granules together, thus forming a non-absorbent cellular slab.

Plaster Wall Boards

Manufacture.—Gypsum is the basic material used in the manufacture of plaster wall boards and, as already referred to in the notes on plaster of Paris, the gypsum is obtained from quarries or by a mining process.

When obtained, it is placed in a crusher where it is broken down to pieces corresponding to pebble size and afterwards conveyed on a picking belt to be delivered into a rotary drier.

Sometimes a magnetic separator is installed in conjunction with the picking belt to assist in preventing any foreign matter, and particularly iron, being carried forward to the other processes.

When the gypsum has been thoroughly dried and the free moisture removed, it is fed into a hammer mill, where it is pulverised and afterwards calcined in special kilns, often termed 'kettles.'

The manufacture of the plaster board commences in a mixing machine, from whence the mixed plaster is delivered on to a board-making machine where it is formed into a continuous sheet.

The best plaster boards are those which have a gypsum cellular core, containing sealed air cells, which tend to lighten the boards and assist the insulative qualities.

The core is sometimes covered with paper which has a wood pulp content, impregnated with plaster, and produces a fairly smooth surface which is usually sized during the process of manufacturing the board. Another type of plaster board is made by mixing a wood fibre filler with the plaster instead of the cellular core mentioned above.

Plaster wall boards have fire-resisting and sound-proofing qualities and if properly applied they may be considered as a permanent means for plastering walls and ceilings.

Plywood

The chief types of plywood are:

(1) Multiple boards of three or more plies.

(2) Laminated boards faced with plywood.

(3) Composite boards.

Plywood has characteristics and possibilities that make it comparable with many other materials for solving decorative problems.

The compound structure of plywood and laminated boards does not rely for its strength upon fibre alone as solid wood does, but upon the direction of the grain and position of the separate layers and core and the success of the gluing processes.

Plywood is formed in several plies of wood which are glued together so that the grain of any one ply is at right angles to the adjoining ply.

These thin layers which build up the board are termed veneers and the boards are graded according to the quality of the facing veneers.

The principal timbers used in the manufacture of plywood are: Birch, Alder, Gaboon Mahogany, Douglas Fir, Oak and Ash. The direction of the rotary cutting and the resultant

position of the annual rings in the face of the veneer, produces a surface that is twice as hard as solid timber and the built-up boards are about six times as strong as solid boards of the same thickness. Owing to the large sizes in which plywood can be obtained it is used extensively for doors, panels, partition walls and as a means for carrying out internal decorative treatments.

The standard sizes range from 24″ to 60″ wide and up to 120″ long and the thickness of the boards varies from $\frac{3}{16}$″ to 1″.

Manufacture.—The logs are cut into suitable lengths and placed in steam heated chambers where they are thoroughly soaked for a period of ten hours.

After soaking they are placed in turning lathes and cut into veneers about $\frac{1}{16}$″ thick by 5′ wide.

This process is similar to opening out a roll of paper and continues until the log is reduced to about 8″ diameter, when the log is removed from the lathe and cut in half and the process of veneer-cutting continued.

The sheets of veneer are cut roughly to standard size and then placed in a rotary drier.

When thoroughly dry they are placed in a mechanical press and flattened out ready for the gluing process which is done by covering the surfaces of the plies with a water-resisting glue, building up the plies and subjecting them to extreme pressure.

The sheets are edge-trimmed and taken to drying kilns for the final drying process, which ensures a balanced moisture content.

The laminated board is a development of plywood. It consists of two or more outer layers of $\frac{1}{8}$″ ply and a centre core composed of numerous strips of wood which are cemented together and the outer plies cemented to the edges of these strips. The construction of the core prevents shrinkage and warping and renders the board sufficiently stiff and strong to dispense with framing.

Laminated boards may be obtained in sheets 5′ wide × 15′ long and from $\frac{1}{2}$″ to $1\frac{1}{2}$″ thick. Blockboards are similar to laminated boards except that the strips forming the core are about twice as thick.

When additional thickness and strength are required two boards may be cemented together in preference to increasing the width of the strips comprising the core.

Lead Pipes

When lead is used for water, soil, waste and ventilating pipes it is usually in the form of drawn lead.

Although it is usual to infer that drawn-lead pipes are round in section, square section pipes can be obtained, and these are perfectly even in substance and true to shape.

The size of lead pipes is measured to the internal diameter and stated in pounds per linear yard.

Pipes up to 1½″ diameter are supplied in rolls, whereas those of 2″ diameter and over are supplied in straight lengths, from 10′ to 12′ long.

A 3½″ diameter pipe weighs about 65 lb. per 10′ length.

Solders

Solders are alloys of metals and should contain a large proportion of the metal to be jointed; the solder fuses at a temperature lower than the metals to be jointed by it.

The usual mixture is 2 parts lead to 1 part tin. Lead pipes are joined together by means of wiped soldered joints.

Manufacture.—The process of manufacture of lead pipes is carried out in the following manner.

The molten lead is poured into the container of a special pipe-making machine which is fitted with a core and die, set in position to suit the diameter and thickness of the pipe walls, as required.

The lead is allowed to remain in the container until the temperature of the metal is reduced to 480° to 500° Fah. when a ram is set in motion thereby exerting a great pressure on the lead, forcing it through the core and die and causing it to escape from the machine in the form of a pipe.

Copper

Apart from its well known electric conductive qualities, the value of copper for building requirements depends chiefly

upon its malleability, ductility and its resistance to corrosion.

The mechanical working or dressing of copper tends to affect its malleability so that it becomes work-hardened by repeated hammering.

It is much used in the form of sheets for roofing purposes and as tubing for hot water and domestic services.

Roofing sheets are usually made of hot-rolled copper which because of its softness and pliability, lends itself to dressing to fit required shapes.

Cold-rolled sheets are harder and stronger and less ductible.

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